JOHN DEERE
WORLDWIDE COMMERCIAL & CONSUMER EQUIPMENT DIVISION

Lawn Tractors LX255, LX266, LX277, LX277AWS, LX279 and LX288

TM1754 APRIL 2005

TECHNICAL MANUAL

JOHN DEERE

North American Version
Litho in U.S.A.

INTRODUCTION

Manual Description

This technical manual is written for an experienced technician and contains sections that are specifically for this product. It is a part of a total product support program.

The manual is organized so that all the information on a particular system is kept together. The order of grouping is as follows:

- Table of Contents
- Specifications and Information
- Identification Numbers
- Tools and Materials
- Component Location
- Schematics and Harnesses
- Theory of Operation
- Operation and Diagnostics
- Diagnostics
- Tests and Adjustments
- Repair
- Other

NOTE: Depending on the particular section or system being covered, not all of the above groups may be used.

The bleed tabs for the pages of each section will align with the sections listed on this page. Page numbering is consecutive from the beginning of the Safety section through the last section.

We appreciate your input on this manual. If you find any errors or want to comment on the layout of the manual please contact us.

Safety
Specifications and Information
Engine - Kohler
Engine - Kawasaki FHV
Engine - Kawasaki FDV
Engine - Briggs and Stratton
Electrical
Power Train
Steering
Attachments
Miscellaneous

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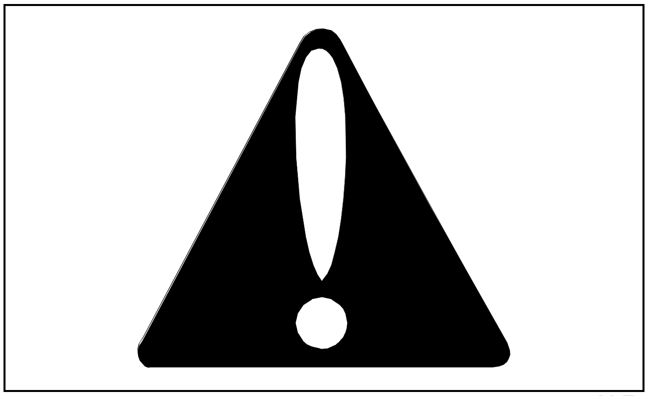
Recognize Safety Information



MIF

This is the safety-alert symbol. When you see this symbol on your machine or in this manual, be alert to the potential for personal injury.

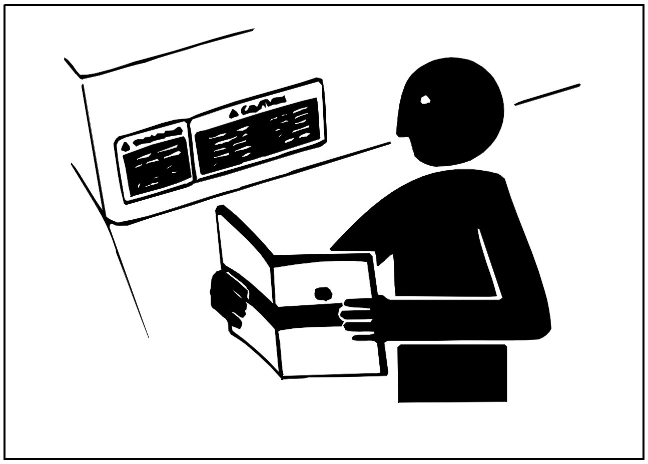
Follow recommended precautions and safe servicing practices.

Understand Signal Words

A signal word - DANGER, WARNING, or CAUTION - is used with the safety-alert symbol. DANGER identifies the most serious hazards.

DANGER or WARNING safety signs are located near specific hazards. General precautions are listed on CAUTION safety signs. CAUTION also calls attention to safety messages in this manual.

Replace Safety Signs



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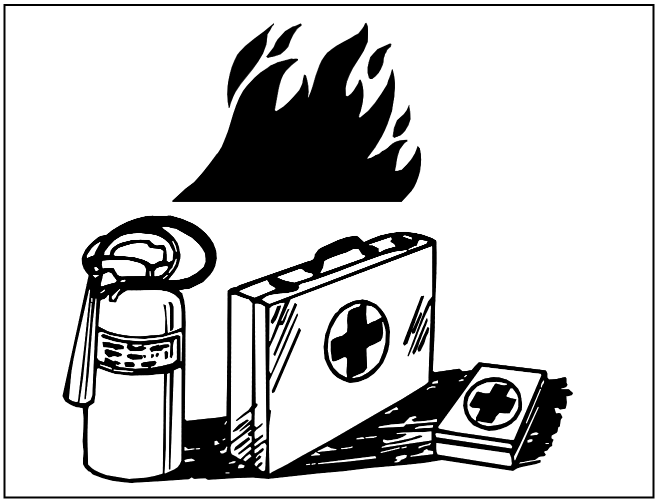
Replace missing or damaged safety signs. See the machine operator's manual for correct safety sign placement.

Handle Fluids Safely - Avoid Fires

Be Prepared For Emergencies



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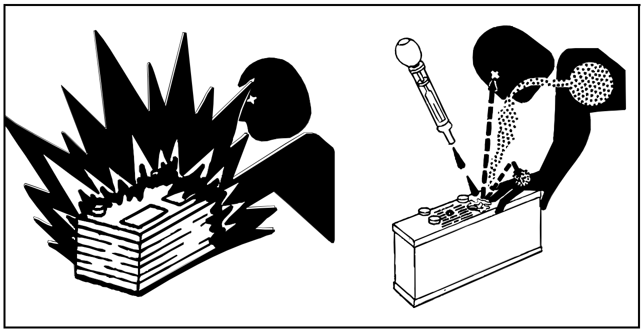
- When you work around fuel, do not smoke or work near heaters or other fire hazards.
- Store flammable fluids away from fire hazards. Do not incinerate or puncture pressurized containers.
- Make sure machine is clean of trash, grease, and debris.
- Do not store oily rags; they can ignite and burn spontaneously.
- Be prepared if a fire starts.
- Keep a first aid kit and fire extinguisher handy.
- Keep emergency numbers for doctors, ambulance service, hospital, and fire department near your telephone.

Use Care In Handling and Servicing Batteries



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Prevent Battery Explosions

- Keep sparks, lighted matches, and open flame away from the top of battery. Battery gas can explode.
- Never check battery charge by placing a metal object

across the posts. Use a volt-meter or hydrometer.

- Do not charge a frozen battery; it may explode. Warm battery to 16°C (60°F).

Prevent Acid Burns

- Sulfuric acid in battery electrolyte is poisonous. It is strong enough to burn skin, eat holes in clothing, and cause blindness if splashed into eyes.

Avoid acid burns by:

1. Filling batteries in a well-ventilated area.
2. Wearing eye protection and rubber gloves.
3. Avoiding breathing fumes when electrolyte is added.
4. Avoiding spilling or dripping electrolyte.
5. Use proper jump start procedure.

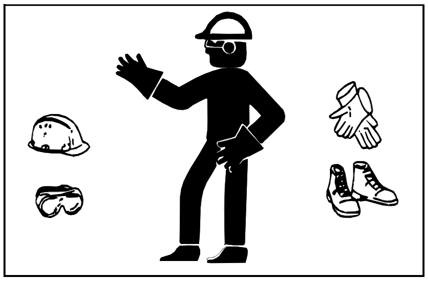
If you spill acid on yourself:

1. Flush your skin with water.
2. Apply baking soda or lime to help neutralize the acid.
3. Flush your eyes with water for 10 - 15 minutes.
4. Get medical attention immediately.

If acid is swallowed:

1. Drink large amounts of water or milk.
2. Then drink milk of magnesia, beaten eggs, or vegetable oil.
3. Get medical attention immediately.

Wear Protective Clothing



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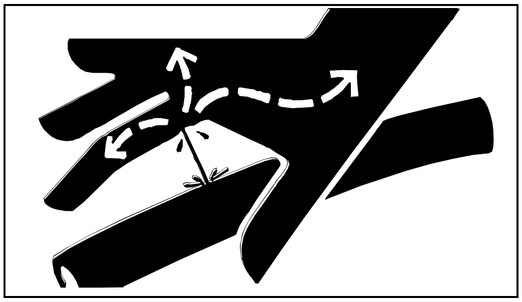
Wear close fitting clothing and safety equipment appropriate to the job.

Prolonged exposure to loud noise can cause impairment or loss of hearing. Wear a suitable hearing protective device such as earmuffs or earplugs to protect against objectionable or uncomfortable loud noises.

Operating equipment safely requires the full attention of the operator. Do not wear radio or music headphones while operating machine.

Use Care Around High-pressure Fluid Lines

Avoid High-Pressure Fluids



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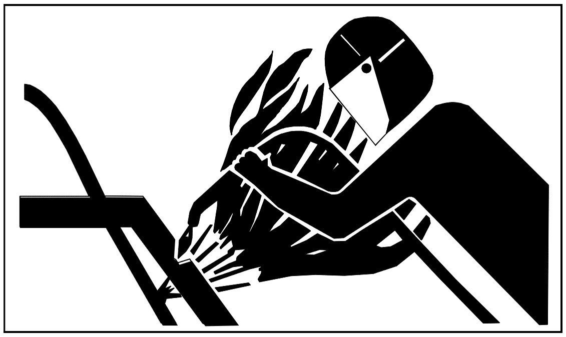
Escaping fluid under pressure can penetrate the skin causing serious injury.

Avoid injury from escaping fluid under pressure by stopping the engine and relieving pressure in the system before disconnecting or connecting hydraulic or other lines. Tighten all connections before applying pressure.

Search for leaks with a piece of cardboard. Protect hands and body from high pressure fluids.

If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available from Deere & Company Medical Department in Moline, Illinois, U.S.A.

Avoid Heating Near Pressurized Fluid Lines



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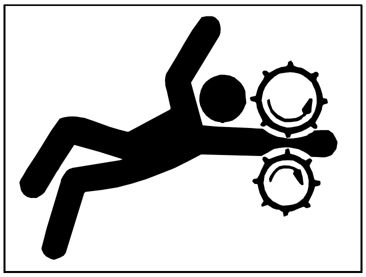
Flammable spray can be generated by heating near pressurized fluid lines, resulting in severe burns to yourself and bystanders. Do not heat by welding, soldering, or using a torch near pressurized fluid lines or other flammable materials. Pressurized lines can be accidentally cut when heat goes beyond the immediate flame area.

Service Machines Safely



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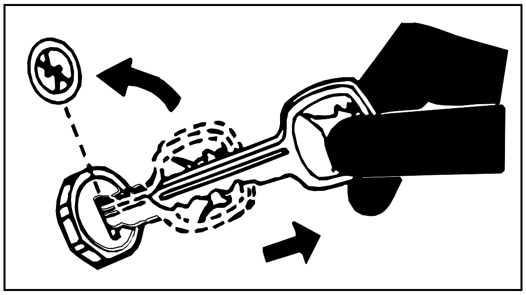
Tie long hair behind your head. Do not wear a necktie, scarf, loose clothing, or necklace when you work near machine tools or moving parts. If these items were to get caught, severe injury could result.

Remove rings and other jewelry to prevent electrical shorts and entanglement in moving parts.

Use Proper Tools

Use tools appropriate to the work. Makeshift tools and procedures can create safety hazards. Use power tools only to loosen threaded parts and fasteners. For loosening and tightening hardware, use the correct size tools. DO NOT use U.S. measurement tools on metric fasteners. Avoid bodily injury caused by slipping wrenches. Use only service parts meeting John Deere specifications.

Park Machine Safely



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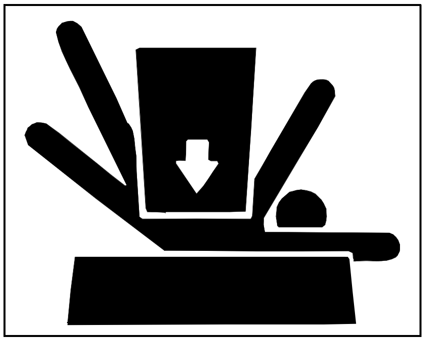
Before working on the machine:

1. Lower all equipment to the ground.
2. Stop the engine and remove the key.
3. Disconnect the battery ground strap.
4. Hang a “DO NOT OPERATE” tag in operator station.

Support Machine Properly and Use Proper Lifting Equipment



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If you must work on a lifted machine or attachment, securely support the machine or attachment.

Do not support the machine on cinder blocks, hollow tiles, or props that may crumble under continuous load. Do not work under a machine that is supported solely by a jack. Follow recommended procedures in this manual.

Lifting heavy components incorrectly can cause severe injury or machine damage. Follow recommended procedure for removal and installation of components in the manual.

Work In Clean Area

Before starting a job:

1. Clean work area and machine.
2. Make sure you have all necessary tools to do your job.
3. Have the right parts on hand.
4. Read all instructions thoroughly; do not attempt shortcuts.

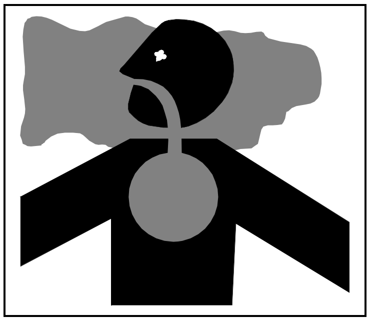
Using High Pressure Washers

Directing pressurized water at electronic/electrical components or connectors, bearings, hydraulic seals, fuel injection pumps or other sensitive parts and components may cause product malfunctions. Reduce pressure and spray at a 45 to 90 degree angle.

Illuminate Work Area Safely

Illuminate your work area adequately but safely. Use a portable safety light for working inside or under the machine. Make sure the bulb is enclosed by a wire cage. The hot filament of an accidentally broken bulb can ignite spilled fuel or oil.

Work In Ventilated Area



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Engine exhaust fumes can cause sickness or death. If it is necessary to run an engine in an enclosed area, remove the exhaust fumes from the area with an exhaust pipe extension.

If you do not have an exhaust pipe extension, open the doors and get outside air into the area.

Warning: California Proposition 65 Warning

Gasoline engine exhaust from this product contains chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm.

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

Remove Paint Before Welding or Heating

Avoid potentially toxic fumes and dust. Hazardous fumes can be generated when paint is heated by welding, soldering, or using a torch. Do all work outside or in a well ventilated area. Dispose of paint and solvent properly. Remove paint before welding or heating: If you sand or grind paint, avoid breathing the dust. Wear an approved respirator. If you use solvent or paint stripper, remove stripper with soap and water before welding. Remove solvent or paint stripper containers and other flammable material from area. Allow fumes to disperse at least 15 minutes before welding or heating.

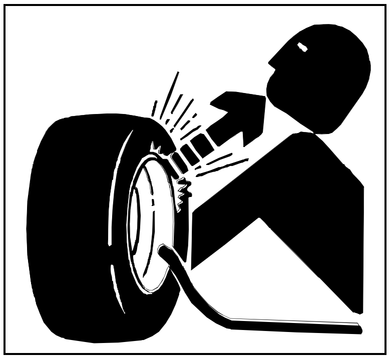
Avoid Harmful Asbestos Dust

Avoid breathing dust that may be generated when handling components containing asbestos fibers. Inhaled asbestos fibers may cause lung cancer.

Components in products that may contain asbestos fibers are brake pads, brake band and lining assemblies, clutch plates, and some gaskets. The asbestos used in these components is usually found in a resin or sealed in some way. Normal handling is not hazardous as long as airborne dust containing asbestos is not generated.

Avoid creating dust. Never use compressed air for cleaning. Avoid brushing or grinding material containing asbestos. When servicing, wear an approved respirator. A special vacuum cleaner is recommended to clean asbestos. If not available, apply a mist of oil or water on the material containing asbestos. Keep bystanders away from the area.

Service Tires Safely



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Explosive separation of a tire and rim parts can cause serious injury or death.

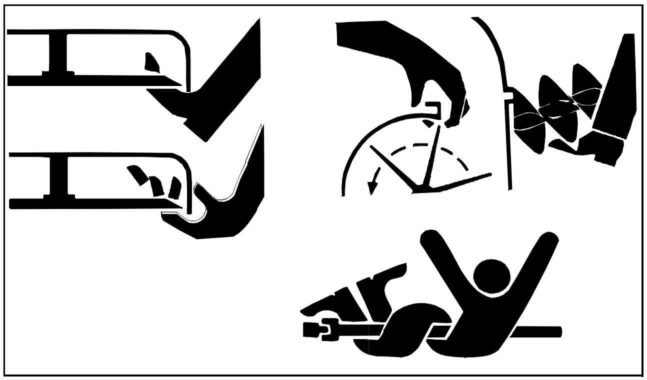
Do not attempt to mount a tire unless you have the proper equipment and experience to perform the job.

Always maintain the correct tire pressure. Do not inflate the tires above the recommended pressure. Never weld or heat a wheel and tire assembly. The heat can cause an increase in air pressure resulting in a tire explosion. Welding can structurally weaken or deform the wheel.

When inflating tires, use a clip-on chuck and extension hose long enough to allow you to stand to one side and NOT in front of or over the tire assembly. Use a safety cage if available.

Check wheels for low pressure, cuts, bubbles, damaged rims or missing lug bolts and nuts.

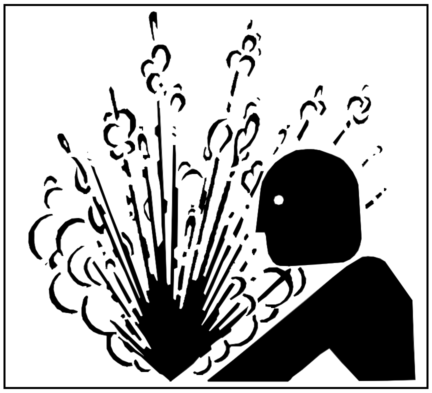
Avoid Injury From Rotating Blades, Augers and PTO Shafts



MIF

Keep hands and feet away while machine is running. Shut off power to service, lubricate or remove mower blades, augers or PTO shafts.

Service Cooling System Safely



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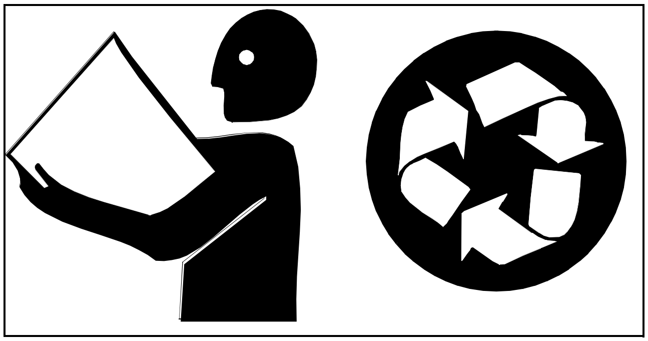
Explosive release of fluids from pressurized cooling system can cause serious burns.

Shut off machine. Only remove filler cap when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing completely.

Handle Chemical Products Safely



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Direct exposure to hazardous chemicals can cause serious injury. Potentially hazardous chemicals used with John Deere equipment include such items as lubricants, coolants, paints, and adhesives.

A Material Safety Data Sheet (MSDS) provides specific details on chemical products: physical and health hazards, safety procedures, and emergency response techniques. Check the MSDS before you start any job using a hazardous chemical. That way you will know exactly what the risks are and how to do the job safely. Then follow procedures and recommended equipment.

Dispose of Waste Properly

Improperly disposing of waste can threaten the environment and ecology. Potentially harmful waste used with John Deere equipment include such items as oil, fuel, coolant, brake fluid, filters, and batteries. Use leakproof containers when draining fluids. Do not use food or beverage containers that may mislead someone into drinking from them. Do not pour waste onto the ground, down a drain, or into any water source. Inquire on the proper way to recycle or dispose of waste from your local environmental or recycling center, or from your John Deere dealer.

Live With Safety

SAFETY
live with it

MIF

Before returning machine to customer, make sure machine is functioning properly, especially the safety systems. Install all guards and shields.

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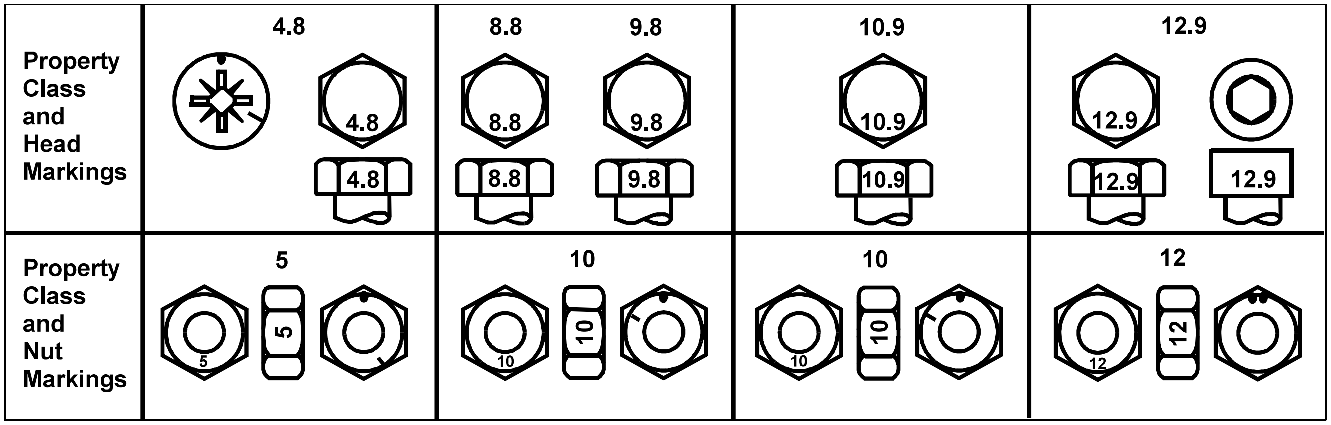
Fastener Torques

Metric Fastener Torque Values



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	Class 4.8				Class 8.8 or 9.8				Class 10.9				Class 12.9			
	Lubricated a		Dry a		Lubricated a		Dry a		Lubricated a		Dry a		Lubricated a		Dry a	
SIZE	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft
M6	4.8	3.5	6	4.5	9	6.5	11	8.5	13	9.5	17	12	15	11.5	19	14.5
M8	12	8.5	15	11	22	16	28	20	32	24	40	30	37	28	47	35
M10	23	17	29	21	43	32	55	40	63	47	80	60	75	55	95	70
M12	40	29	50	37	75	55	95	70	110	80	140	105	130	95	165	120
M14	63	47	80	60	120	88	150	110	175	130	225	165	205	150	260	109
M16	100	73	125	92	190	140	240	175	275	200	350	225	320	240	400	300
M18	135	100	175	125	260	195	330	250	375	275	475	350	440	325	560	410
M20	190	140	240	180	375	275	475	350	530	400	675	500	625	460	800	580
M22	260	190	330	250	510	375	650	475	725	540	925	675	850	625	1075	800
M24	330	250	425	310	650	475	825	600	925	675	1150	850	1075	800	1350	1000
M27	490	360	625	450	950	700	1200	875	1350	1000	1700	1250	1600	1150	2000	1500
M30	675	490	850	625	1300	950	1650	1200	1850	1350	2300	1700	2150	1600	2700	2000
M33	900	675	1150	850	1750	1300	2200	1650	2500	1850	3150	2350	2900	2150	3700	2750
M36	1150	850	1450	1075	2250	1650	2850	2100	3200	2350	4050	3000	3750	2750	4750	3500

DO NOT use these hand torque values if a different torque value or tightening procedure is given for a specific application. Torque values listed are for general use only and include a ±10% variance factor. Check tightness of fasteners periodically. DO NOT use air powered wrenches.

Shear bolts are designed to fail under predetermined loads. Always replace shear bolts with identical grade.

Fasteners should be replaced with the same grade. Make sure fastener threads are clean and that you properly start thread engagement. This will prevent them from failing when tightening.

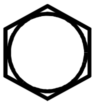
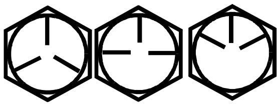
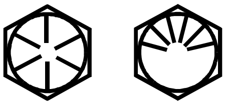
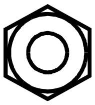
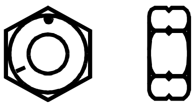
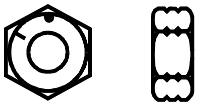
When bolt and nut combination fasteners are used, torque values should be applied to the NUT instead of the bolt head.

Tighten toothed or serrated-type lock nuts to the full torque value.

a “Lubricated” means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings. “Dry” means plain or zinc plated (yellow dichromate - Specification JDS117) without any lubrication.

Reference: JDS - G200.

Inch Fastener Torque Values

SAE Grade and Head Markings	**1 or 2**[b] **No Marks** 	**5 5.1 5.2** 	**8 8.2** 
SAE Grade and Nut Markings	**2** **No Marks** 	**5** 	**8** 

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	Grade 1				Grade 2b				Grade 5, 5.1 or 5.2				Grade 8 or 8.2			
	Lubricated a		Dry a		Lubricated a		Dry a		Lubricated a		Dry a		Lubricated a		Dry a	
SIZE	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft	N•m	lb-ft
1/4	3.7	2.8	4.7	3.5	6	4.5	7.5	5.5	9.5	7	12	9	13.5	10	17	12.5
5/16	7.7	5.5	10	7	12	9	15	11	20	15	25	18	28	21	35	26
3/8	14	10	17	13	22	16	27	20	35	26	44	33	50	36	63	46
7/16	22	16	28	20	35	26	44	32	55	41	70	52	80	58	100	75
1/2	33	25	42	31	53	39	67	50	85	63	110	80	120	90	150	115
9/16	48	36	60	45	75	56	95	70	125	90	155	115	175	130	225	160
5/8	67	50	85	62	105	78	135	100	170	125	215	160	215	160	300	225
3/4	120	87	150	110	190	140	240	175	300	225	375	280	425	310	550	400
7/8	190	140	240	175	190	140	240	175	490	360	625	450	700	500	875	650
1	290	210	360	270	290	210	360	270	725	540	925	675	1050	750	1300	975
1-1/8	470	300	510	375	470	300	510	375	900	675	1150	850	1450	1075	1850	1350
1-1/4	570	425	725	530	570	425	725	530	1300	950	1650	1200	2050	1500	2600	1950
1-3/8	750	550	950	700	750	550	950	700	1700	1250	2150	1550	2700	2000	3400	2550
1-1/2	1000	725	1250	925	990	725	1250	930	2250	1650	2850	2100	3600	2650	4550	3350

DO NOT use these hand torque values if a different torque value or tightening procedure is given for a specific application. Torque values listed are for general use only and include a ±10% variance factor. Check tightness of fasteners periodically. DO NOT use air powered wrenches.

Shear bolts are designed to fail under predetermined loads. Always replace shear bolts with identical grade.

Fasteners should be replaced with the same grade. Make sure fastener threads are clean and that you properly start thread engagement. This will prevent them from failing when tightening.

When bolt and nut combination fasteners are used, torque values should be applied to the NUT instead of the bolt head.

Tighten toothed or serrated-type lock nuts to the full torque value.

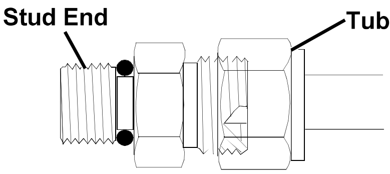
a “Lubricated” means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings. “Dry” means plain or zinc plated (yellow dichromate - Specification JDS117) without any lubrication.

b “Grade 2” applies for hex cap screws (Not Hex Bolts) up to 152 mm (6 in.) long. “Grade 1” applies for hex cap screws over 152 mm (6 in.) long, and for all other types of bolts and screws of any length.

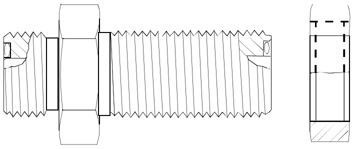
Reference: JDS - G200

O-Ring Seal Service Recommendations

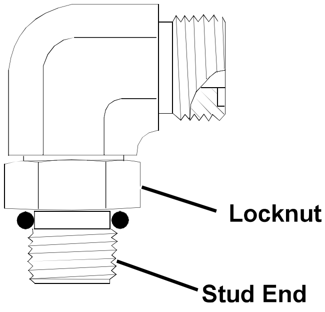
Face Seal Fittings With Inch Stud Ends Torque



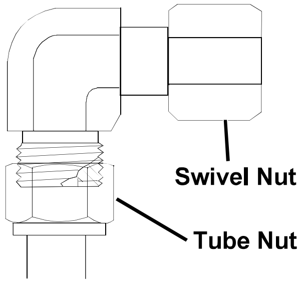
Stud Straight and Tube Nut



Bulkhead Union and Bulkhead Locknut



90 Adjustable Stud Elbow



90 Swivel Elbow and Tube Nut

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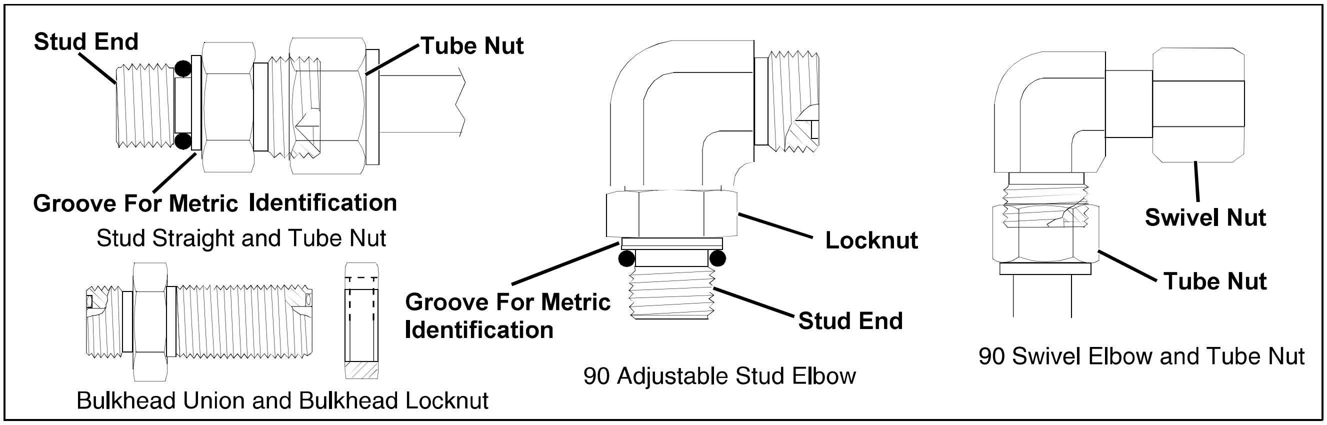
Nominal Tube OD/Hose ID				Face Seal Tube/Hose End					O-Ring Stud Ends		
Metric Tube OD	Inch Tube OD			Thread Size	Tube Nut/ Swivel Nut Torque		Bulkhead Lock Nut Torque		Thread Size	Straight Fitting or Lock Nut Torque	
mm	Dash Size	in.	mm	in.	N•m	lb-ft	N•m	lb-ft	in.	N•m	lb-ft
5	-3	0.188	4.76						3/8-24	8	6
6	-4	0.250	6.35	9/16-18	16	12	12	9	7/16-20	12	9
8	-5	0.312	7.94						1/2-20	16	12
10	-6	0.375	9.52	11/16-16	24	18	24	18	9/16-18	24	18
12	-8	0.500	12.70	13/16-16	50	37	46	34	3/4-16	46	34
16	-10	0.625	15.88	1-14	69	51	62	46	7/8-14	62	46
19	-12	0.750	19.05	1-3/16-12	102	75	102	75	1-1/16-12	102	75
22	-14	0.875	22.22	1-3/16-12	102	75	102	75	1-3/16-12	122	90
25	-16	1.000	25.40	1-7/16-12	142	105	142	105	1-5/16-12	142	105
32	-20	1.25	31.75	1-11/16-12	190	140	190	140	1-5/8-12	190	140
38	-24	1.50	38.10	2-12	217	160	217	160	1-7/8-12	217	160

NOTE: Torque tolerance is +15%, -20%

Face Seal Fittings With Metric Stud Ends Torque

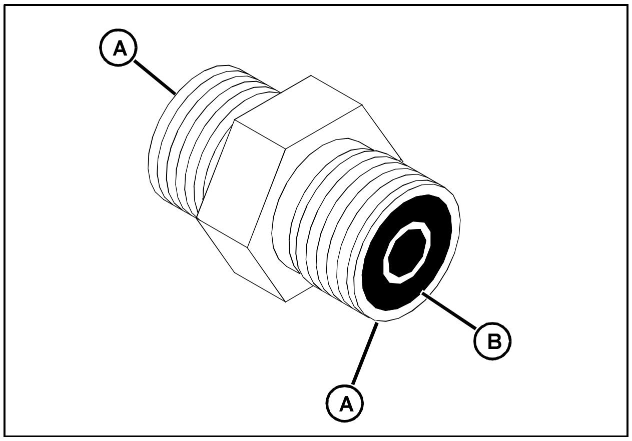

Stud End
Tube Nut
Groove For Metric Identification
Stud Straight and Tube Nut
Bulkhead Union and Bulkhead Locknut
Locknut
Groove For Metric Identification
Stud End
90 Adjustable Stud Elbow
Swivel Nut
Tube Nut
90 Swivel Elbow and Tube Nut

MIF

Nominal Tube OD/Hose ID				Face Seal Tube/Hose End						O-Ring Stud Ends, Straight Fitting or Lock Nut					
Metric Tube OD	Inch Tube OD			Thread Size	Hex Size	Tube Nut/ Swivel Nut Torque		Bulkhead Lock Nut Torque		Thread Size	Hex Size	Steel or Gray Iron Torque		Aluminum Torque	
mm	Dash Size	in.	mm	in.	mm	N•m	lb-ft	N•m	lb-ft	mm	mm	N•m	lb-ft	N•m	lb-ft
6	-4	0.250	6.35	9/16-18	17	16	12	12	9	M12X1.5	17	21	15.5	9	6.6
8	-5	0.312	7.94												
										M14X1.5	19	33	24	15	11
10	-6	0.375	9.52	11/16-16	22	24	18	24	18	M16X1.5	22	41	30	18	13
12	-8	0.500	12.70	13/16-16	24	50	37	46	34	M18X1.5	24	50	37	21	15
16	-10	0.625	15.88	1-14	30	69	51	62	46	M22X1.5	27	69	51	28	21
	-12	0.750	19.05	1-3/16-12	36	102	75	102	75	M27X2	32	102	75	46	34
22	-14	0.875	22.22	1-3/16-12	36	102	75	102	75	M30X2	36				
25	-16	1.000	25.40	1-7/16-12	41	142	105	142	105	M33X2	41	158	116	71	52
28										M38X2	46	176	130	79	58
32	-20	1.25	31.75	1-11/16-12	50	190	140	190	140	M42X2	50	190	140	85	63
38	-24	1.50	38.10	2-12	60	217	160	217	160	M48X2	55	217	160	98	72

NOTE: Torque tolerance is +15%, -20%

O-ring Face Seal Fittings



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1. Inspect the fitting sealing surfaces (A). They must be free of dirt or defects.

2. Inspect the O-ring (B). It must be free of damage or defects.

3. Lubricate O-rings and install into groove using petroleum jelly to hold in place during assembly.

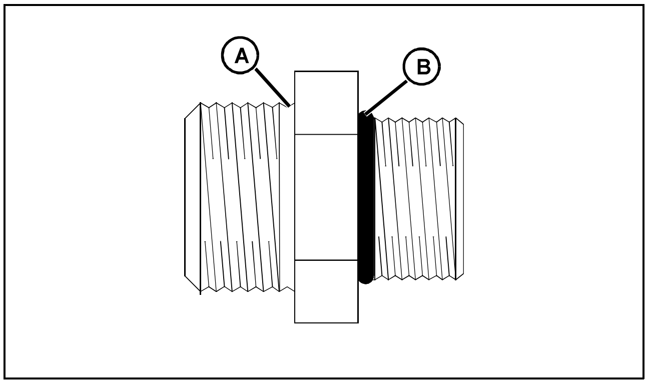
4. Index angle fittings and tighten by hand pressing joint together to insure O-ring remains in place.

IMPORTANT: Avoid damage! DO NOT allow hoses to twist when tightening fittings. Use two wrenches to tighten hose connections; one to hold the hose, and the other to tighten the swivel fitting.

5. Tighten fitting or nut to torque value shown on the chart per dash size stamped on the fitting.

O-Ring Boss Fittings

1. Inspect boss O-ring boss seat. It must be free of dirt and defects. If repeated leaks occur, inspect for defects with a magnifying glass. Some raised defects can be removed with a slip stone.



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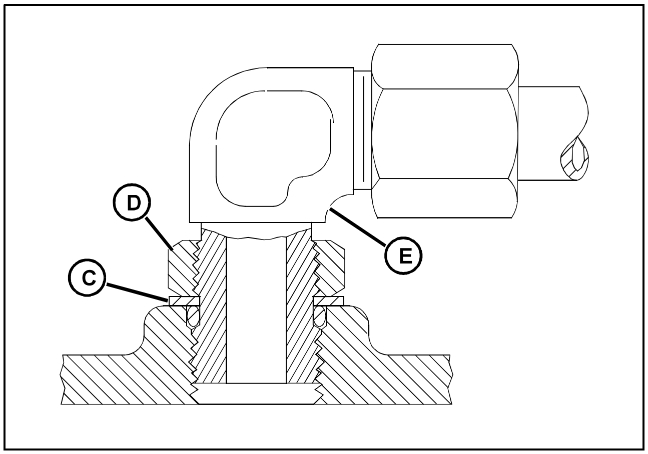
2. Put hydraulic oil or petroleum jelly on the O-ring (B). Place electrical tape over the threads to protect O-ring from nicks. Slide O-ring over the tape and into the groove (A) of fitting. Remove tape.



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3. For angle fittings, loosen special nut (D) and push special washer (C) against threads so O-ring can be installed into the groove of fitting.

4. Turn fitting into the boss by hand until special washer or washer face (straight fitting) contacts boss face and O-ring is squeezed into its seat.

5. To position angle fittings (E), turn the fitting counterclockwise a maximum of one turn.

6. Tighten straight fittings to torque value shown on chart. For angle fittings, tighten the special nut to value shown in the chart while holding body of fitting with a wrench.

Straight Fitting or Special Nut Torques

Thread Size	Torque[a]		Number of Flats[b]
	N•m	lb-ft	
3/8-24 UNF	8	6	2
7/16-20 UNF	12	9	2
1/2-20 UNF	16	12	2
9/16-18 UNF	24	18	2
3/4-16 UNF	46	34	2
7/8-14 UNF	62	46	1-1/2
1-1/16-12 UN	102	75	1
1-3/16-12 UN	122	90	1
1-5/16-12 UN	142	105	3/4
1-5/8-12 UN	190	140	3/4

Thread Size	Torque[a]		Number of Flats[b]
	N•m	lb-ft	
1-7/8-12 UN	217	160	1/2

[a] Torque tolerance is ± 10 percent.

[b] To be used if a torque wrench cannot be used. After tightening fitting by hand, put a mark on nut or boss; then tighten special nut or straight fitting the number of flats shown.

Metric Fastener Torque Value - Grade 7 (Special)

Size	Steel or Gray Iron Torque	Aluminum Torque
	N•m (lb-ft)	N•m (lb-ft)
M6	11 (8)	8 (6)
M8	24 (18)	19 (14)
M10	52 (38)	41 (30)
M12	88 (65)	70 (52)
M14	138 (102)	111 (82)
M16	224 (165)	179 (132)

General Information

Gasoline

4 - Cycle Engines

CAUTION: Avoid Injury! Gasoline is HIGHLY FLAMMABLE, handle it with care. DO NOT refuel machine while: indoors, always fill gas tank outdoors; machine is near an open flame or sparks; engine is running, STOP engine; engine is hot, allow it to cool sufficiently first; smoking. Help prevent fires: fill gas tank to bottom of filler neck only; be sure fill cap is tight after fueling; clean up any gas spills IMMEDIATELY; keep machine clean and in good repair - free of excess grease, oil, debris, and faulty or damaged parts; any storage of machines with gas left in tank should be in an area that is well ventilated to prevent possible igniting of fumes by an open flame or spark, this includes any appliance with a pilot light. To prevent fire or explosion caused by STATIC ELECTRIC DISCHARGE during fueling:•ONLY use a clean, approved POLYETHYLENE PLASTIC fuel container and funnel WITHOUT any metal screen or filter.

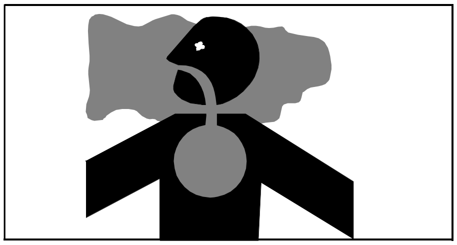
To avoid engine damage:

- DO NOT mix oil with gasoline;
- **ONLY use clean, fresh unleaded gasoline with an octane rating (anti-knock index) of 87 or higher**;
- fill gas tank at the end of each day's operation to help prevent condensation from forming inside a partially filled tank;
- keep up with specified service intervals.

Use of alternative oxygenated, gasohol blended, unleaded gasoline is acceptable as long as:

- the ethyl or grain alcohol blends DO NOT exceed 10% by volume or
- methyl tertiary butyl ether (MTBE) blends DO NOT exceed 15% by volume

RFG (reformulated) gasoline is acceptable for all machines designed for use of regular unleaded fuel. Older machines (that were designed for leaded fuel) may see some accelerated valve and seat wear.



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IMPORTANT: Avoid damage! California Proposition 65 Warning: Gasoline engine exhaust from this product contains chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm.

Gasoline Storage

IMPORTANT: Avoid damage! Keep all dirt, scale, water or other foreign material out of gasoline.

Keep gasoline stored in a safe, protected area. Storage of gasoline in a clean, properly marked (“UNLEADED GASOLINE”) POLYETHYLENE PLASTIC container WITHOUT any metal screen or filter is recommended. DO NOT use de-icers to attempt to remove water from gasoline or depend on fuel filters to remove water from gasoline. Use a water separator installed in the storage tank outlet. BE SURE to properly discard unstable or contaminated gasoline. When storing the machine or gasoline, it is recommended that you add **John Deere Gasoline Conditioner and Stabilizer (TY15977)** or an equivalent to the gasoline. BE SURE to follow directions on container and to properly discard empty container.

4 - Cycle Gasoline Engine Oil

Use the appropriate oil viscosity based on the expected air temperature range during the period between recommended oil changes. Operating outside of these recommended oil air temperature ranges may cause premature engine failure.

The following John Deere oils are PREFERRED:

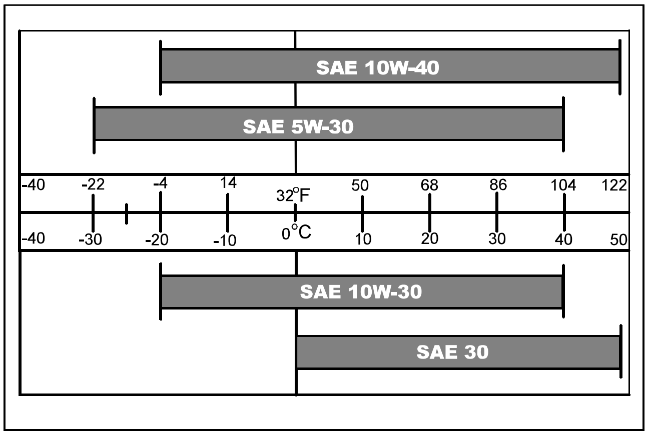
- **PLUS - 4® - SAE 10W-40**;
- **TORQ - GARD SUPREME® - SAE 5W-30.**

The following John Deere oils are **also recommended**, based on their specified temperature range:

- **TURF - GARD® - SAE 10W-30;**
- **PLUS - 4® - SAE 10W-30;**
- **TORQ - GARD SUPREME® - SAE 30.**

Other oils may be used if above John Deere oils are not available, provided they meet one of the following specifications:

- SAE 10W-40 - API Service Classifications SG or higher;
- SAE 5W-30 - API Service Classification SG or higher;
- SAE 10W-30 - API Service Classifications SG or higher;
- SAE 30 - API Service Classification SC or higher.



Break-In Engine Oil - 4-Cycle Gasoline

IMPORTANT: Avoid damage! ONLY use a quality break-in oil in rebuilt or remanufactured engines for the first 5 hours (maximum) of operation. DO NOT use oils with heavier viscosity weights than SAE 5W-30 or oils meeting specifications API SG or SH, these oils will not allow rebuilt or remanufactured engines to break-in properly.

The following John Deere oil is PREFERRED:

- **BREAK - IN ENGINE OIL.**

John Deere BREAK - IN ENGINE OIL is formulated with special additives for aluminum and cast iron type engines to allow the power cylinder components (pistons, rings, and liners as well) to “wear-in” while protecting other engine components, valve train and gears, from abnormal wear. Engine rebuild instructions should be followed closely to determine if special requirements are necessary.

John Deere BREAK - IN ENGINE OIL is also recommended for non-John Deere engines, both aluminum and cast iron types.

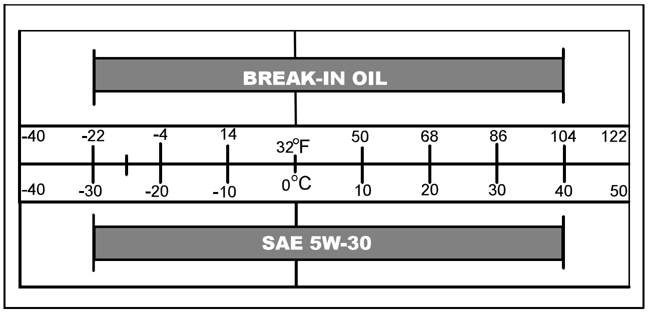
The following John Deere oil is **also recommended**:

- **TORQ - GARD SUPREME® - SAE 5W-30.**

If the above recommended John Deere oils are not available, use a break-in engine oil meeting the following specification during the first **5 hours (maximum)** of operation:

- SAE 5W-30 - API Service Classification SE or higher.

IMPORTANT: Avoid damage! After the break-in period, use the John Deere oil that is recommended for this engine.



Hydrostatic Transmission and Hydraulic Oil

Use the appropriate oil viscosity based on these air temperature ranges. Operating outside of these recommended oil air temperature ranges may cause premature hydrostatic transmission or hydraulic system failures.

IMPORTANT: Avoid damage! Use only the oils recommended. HY-GARD® - JDM J20C can be mixed with 5W30 or 10W30 in this application.

Do not use LOW VISCOSITY HY - GARD® oil.

The following John Deere transmission and hydraulic oil is **PREFERRED**:

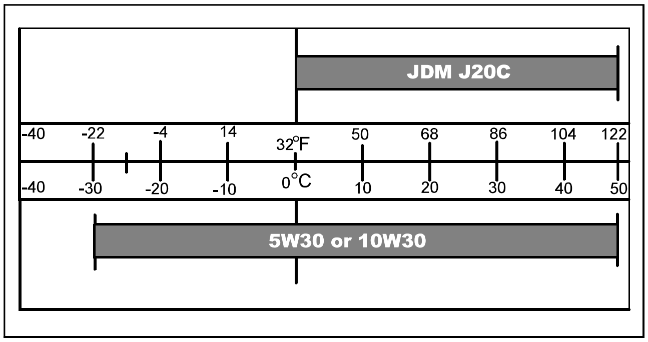
- **HY-GARD® - JDM J20C**.

The following John Deere oil is also recommended if above preferred oil is not available:

- **5W30 or 10W30.**

Other oils may be used if above recommended John Deere oils are not available, provided they meet one of the following specifications:

- John Deere Standard JDM J20C.



Gear Case Oil

Use the appropriate oil viscosity based on the air temperature ranges. Operating outside of these recommended oil air temperature ranges may cause premature gear case failure.

IMPORTANT: Avoid damage! ONLY use a quality oil in this gear case. DO NOT mix any other oils in this gear case. DO NOT use BIO-HY-GARD® in this gear case.

The following John Deere gear case oil is PREFERRED:

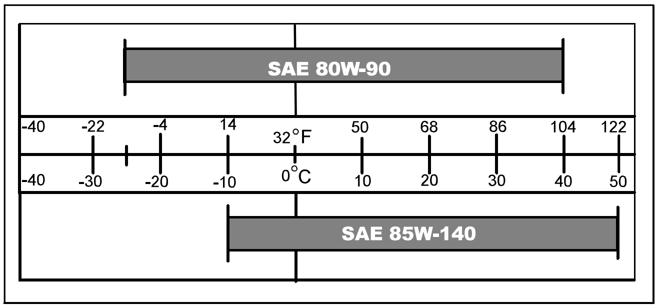
- **GL-5 GEAR LUBRICANT® - SAE 80W-90.**

The following John Deere gear case oil is also recommended if above preferred oil is not available:

- **GL-5 GEAR LUBRICANT® - SAE 85W-140.**

Other gear case oils may be used if above recommended John Deere gear case oils are not available, provided they meet the following specification:

- API Service Classification GL - 5.



Gear Transmission Grease

Use the following gear grease based on the air temperature range. Operating outside of the recommended grease air temperature range may cause premature gear transmission failure.

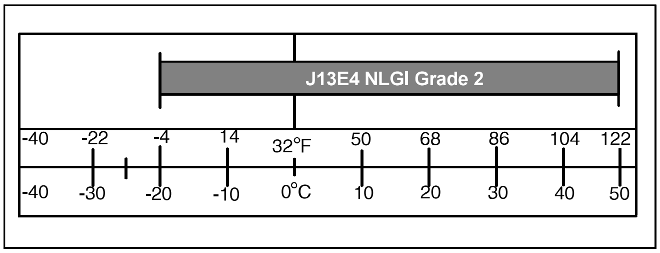
IMPORTANT: Avoid damage! ONLY use a quality gear grease in this transmission. DO NOT mix any other greases in this transmission. DO NOT use any BIO - GREASE in this transmission.

The following John Deere gear grease is PREFERRED:

- **NON-CLAY HIGH-TEMPERATURE EP GREASE®** - JDM J13E4, NLGI Grade 2.

Other greases may be used if above preferred John Deere grease is not available, provided they meet the following specification:

- John Deere Standard JDM J13E4, NLGI Grade 2.



Alternative Lubricants

Use of alternative lubricants could cause reduced life of the component.

If alternative lubricants are to be used, it is recommended that the factory fill be thoroughly removed before switching to any alternative lubricant.

Synthetic Lubricants

Synthetic lubricants may be used in John Deere equipment if they meet the applicable performance requirements (industry classification and/or military specification) as shown in this manual.

The recommended air temperature limits and service or lubricant change intervals should be maintained as shown in the operator’s manual, unless otherwise stated on lubricant label.

Avoid mixing different brands, grades, or types of oil. Oil manufacturers blend additives in their oils to meet certain specifications and performance requirements. Mixing different oils can interfere with the proper functioning of these additives and degrade lubricant performance.

Lubricant Storage

All machines operate at top efficiency only when clean lubricants are used. Use clean storage containers to handle all lubricants. Store them in an area protected from dust, moisture, and other contamination. Store drums on their sides. Make sure all containers are properly marked as to their contents. Dispose of all old, used containers and their contents properly.

Mixing of Lubricants

In general, avoid mixing different brands or types of lubricants. Manufacturers blend additives in their lubricants to meet certain specifications and performance requirements. Mixing different lubricants can interfere with the proper functioning of these additives and lubricant properties which will downgrade their intended specified performance.

Oil Filters

IMPORTANT: Avoid damage! Filtration of oils is critical to proper lubrication performance. Always change filters regularly.

The following John Deere oil filters are PREFERRED:

- AUTOMOTIVE AND LIGHT TRUCK ENGINE OIL FILTERS.

Most John Deere filters contain pressure relief and anti-drainback valves for better engine protection.

Other oil filters may be used if above recommended John Deere oil filters are not available, provided they meet the following specification:

- ASTB Tested In Accordance With SAE J806.

Coolant Specifications

Gasoline Engine Coolant

The engine cooling system when filled with a proper dilution mixture of anti-freeze and deionized or distilled water provides year-round protection against corrosion, cylinder or liner pitting, and winter freeze protection down to **-37°C (-34°F).**

The following John Deere coolant is **PREFERRED**:

- **COOL-GARD® PRE-DILUTED SUMMER COOLANT (TY16036).**

This coolant satisfies specifications for “Automobile and Light Duty Engine Service” and is safe for use in John Deere Lawn and Grounds Care/Golf and Turf Division equipment, including aluminum block gasoline engines and cooling systems.

The above preferred pre-diluted anti-freeze provides:

- adequate heat transfer
- corrosion-resistant chemicals for the cooling system
- compatibility with cooling system hose and seal material
- protection during extreme cold and extreme hot weather operations
- chemically pure water for better service life
- compliance with ASTM D4656 (JDM H24C2) specifications

If above preferred pre-diluted coolant is not available, the following John Deere concentrate is recommended:

- **COOL-GARD® CONCENTRATED SUMMER COOLANT CONCENTRATE™ (TY16034).**

If either of above recommended engine coolants are available use any Automobile and Light Duty Engine

Service ethylene glycol base coolant, meeting the following specification:

- ASTM D4985 (JDM H24A2).

Read container label completely before using and follow instructions as stated.

IMPORTANT: Avoid damage! To prevent engine damage, DO NOT use pure anti-freeze or less than a 50% anti-freeze mixture in the cooling system. DO NOT mix or add any additives/ conditioners to the cooling system in Lawn and Grounds Care/Golf and Turf Division equipment. Water used to dilute engine coolant concentrate must be of high quality - clean, clear, potable water (low in chloride and hardness - Table 1) is generally acceptable. DO NOT use salt water. Deionized or distilled water is ideal to use. Coolant that is not mixed to these specified levels and water purity can cause excessive scale, sludge deposits, and increased corrosion potential.

Property	Requirements
Total Solids, Maximum	340 ppm (20 grns/gal)
Total Hardness, Maximum	170 ppm (10 grns/gal)
Chloride (as Cl), Maximum	40 ppm (2.5 grns/gal)
Sulfate (as SO4), Maximum	100 ppm (5.8 grns/gal)

Mix 50 percent anti-freeze concentrate with 50 percent distilled or deionized water. This mixture and the pre-diluted mixture (TY16036) will protect the cooling system down to **-37°C (-34°F)** and up to **108°C (226°F)**.

Certain geographical areas may require lower air temperature protection. See the label on your anti-freeze container or consult your John Deere dealer to obtain the latest information and recommendations.

Gasoline Engine Coolant Drain Interval

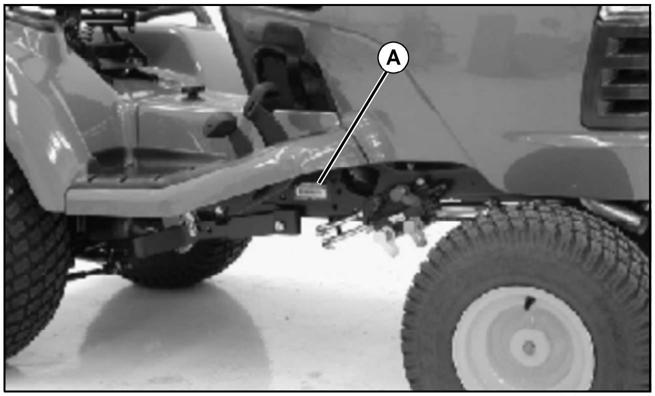
When using John Deere Pre-Diluted (TY16036) Automobile and Light Duty Engine Service coolants, drain and flush the cooling system and refill with fresh coolant mixture every 36 months or 3,000 hours of operation, whichever comes first.

When using John Deere Concentrate (TY16034) Automobile and Light Duty Engine Service coolants, drain and flush the cooling system and refill with fresh coolant mixture every 24 months or 2,000 hours of operation, whichever comes first.

If above John Deere Automobile and Light Duty Engine Service coolants are not being used; drain, flush, and refill the cooling system according to instructions found on product container or in equipment operator's manual or technical manual.

Serial Number Locations

Product Serial Number



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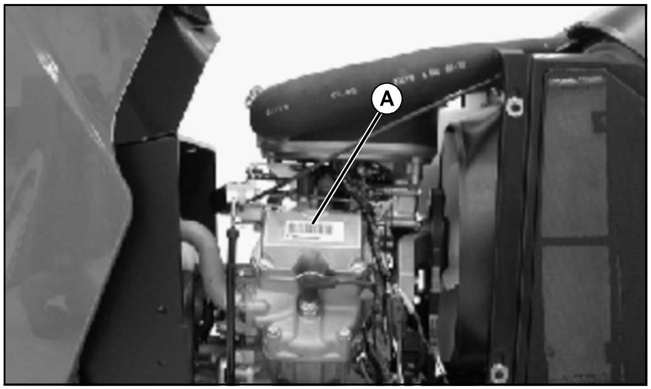
The 13-digit product identification number (A) is located on the right-hand side frame, just below engine compartment.

Gasoline Engine Serial Number Location



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Engine serial number (A) is located on the valve cover.

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Specifications

General Specifications

Make	Kohler
Model Number	CV15S
Power	11.19 kW (15.0 hp)
Displacement	426 cm3 (26.0 cu-in.)
Cylinders	1
Stroke/Cycle	4
Valves	Overhead Valves
Bore	90 mm (3.55 in.)
Stroke (All)	67 mm (2.64 in.)
Compression Ratio	2:1 Cranking - 8.5:1 Running
Compression Release	Automatic/Centrifugal
Crankshaft Type	Vertical (Counterbalanced)
Lubrication	Pressurized Gerotor Pump, 0 - 413 kPa (0 - 60 psi)
Oil Filter	Single Element, Full Flow, Spin-On Filter
Crankcase Oil Capacity w/o Oil Filter)	1.3 L (1.4 qt)
Crankcase Oil Capacity w/ Oil Filter	1.8 L (1.9 qt)
Cooling System	Air Cooled
Air Cleaner	Paper w/ Outer Foam Element
Muffler	Horizontal Discharge Below Frame
Maximum Angle of Operation (With Full Crankcase):	
Continuous (All Directions)	20°
Intermittent (All Directions)	35°
Fuel Filter	Replaceable (In-Line Type)
Fuel Shut-Off Solenoid	Replaceable (Below Carburetor Float Bowl)
Weight	39.5 kg (87 lbs)

Tests and Adjustments Specifications

Engine:

Valve Adjustment	None (Hydraulic Lifters)
Oil Pressure (at 3350 rpm)	69 - 517 kPa (10 - 75 psi)
(Minimum at 1250 rpm)	28 kPa (4 psi)
Crankcase Vacuum (Minimum At Operating Temp.)	102 mm (4.0 in.)
Automatic Compression Release Minimum Lift	0.76 - 1.02 mm (0.030 - 0.040 in.)
Ignition Module Air Gap	0.25 mm (0.010 in.)

Fuel/Air System:

Carburetor Slow Idle Mixture Screw Initial Setting	Lightly Seat, Then 1 Turn Out
Fuel Pressure (Minimum)	6.12 kPa (0.90 psi)
Fuel Flow (Minimum, 15 Seconds)	30 ml (1.0 US oz)
Slow Idle Speed	1550 ± 100 rpm
Fast Idle Speed	3350 ± 50 rpm
Spark Plug Type	Champion RC12YC
Spark Plug Gap	1.0 mm (0.040 in.)
Torque	40 N•m (30 lb-ft)

Repair Specifications

Cylinder Head

Cylinder Head Flatness (Maximum Warp)	0.076 mm (0.003 in.)

Push Rod

Maximum Bend	0.76 mm (0.030 in.)

Valves and Valve Lifters

Hydraulic Lifter Clearance	0.0124 - 0.0501 mm (0.0005 - 0.0020 in.)
Intake Valve-to-Guide Clearance	0.038 - 0.076 mm (0.0015 - 0.0030 in.)
Intake Valve Stem OD	6.982 - 7.000 mm (0.275 - 0.276 in.)
Oversize	7.232 - 7.250 mm (0.284 - 0.285 in.)
Intake Valve Guide ID:	
New	7.038 - 7.058 mm (0.277 - 0.278 in.)
Maximum	7.134 mm (0.281 in.)
Oversize	7.288 - 7.308 mm (0.287 - 0.288 in.)
Exhaust Valve-to-Guide Clearance	0.050 - 0.088 mm (0.002 - 0.0035 in.)
Exhaust Valve Stem OD	6.970 - 6.988 mm (0.274 - 0.275 in.)
Oversize	7.220 - 7.238 mm (0.284 - 0.285 in.)
Exhaust Valve Guide ID:	
New	7.038 - 7.058 mm (0.277 - 0.278 in.)
Maximum	7.159 mm (0.282 in.)
Oversize	7.238 - 7.308 mm (0.285 - 0.288 in.)
Valve Guide Reamer:	
Standard	7.048 mm (0.2775 in.)
Oversize (0.25 mm)	7.298 mm (0.2873 in.)
Intake Valve Lift (Minimum - Engine Cold)	8.96 mm (0.353 in.)
Exhaust Valve Lift (Minimum - Engine Cold)	9.14 mm (0.360 in.)
Valve Face Angle	45°
Valve Seat Angle	44.5°
Valve Margin (Minimum)	1.5 mm (0.059 in.)
Valve Stem Bend (Maximum)	0.076 mm (0.003 in.)

Rocker Arms

Rocker Arm Bearing ID:	
New	15.837 - 16.127 mm (0.63 - 0.64 in.)
Wear Limit	15.727 mm (0.619 in.)

Rocker Shaft

Rocker Shaft OD:	
New	15.837 - 16.127 mm (0.63 - 0.64 in.)
Wear Limit	15.727 mm (0.619 in.)

Crankshaft

End Play	0.0575 - 0.4925 mm (0.0023 - 0.0194 in.)
Crankshaft Bore ID (Crankcase Half):	
New	44.965 - 45.003 mm (1.7703 - 1.7718 in.)
Maximum	45.016 mm (1.7723 in.)
(Clearance (New)	0.03 - 0.09 mm (0.0012 - 0.0035 in.)

Crankshaft Bore (Oil Pan Half):	
New	**44.965 - 45.003 mm (1.7703 - 1.7718 in.)**
Maximum	**45.016 mm (1.7723 in.)**
Clearance (New)	**0.03 - 0.09 mm (0.0012 - 0.0035 in.)**
Main Bearing Journal OD (Flywheel End):	
New	**44.913 - 44.935 mm (1.7682 - 1.7691 in.)**
Minimum	**44.84 mm (1.765 in.)**
Maximum Taper	**0.022 mm (0.0009 in.)**
Maximum Out-of-Round	**0.025 mm (0.0010 in.)**
Main Bearing Journal OD (Oil Pan End):	
New	**41.915 - 41.935 mm (1.6502 - 1.6510 in.)**
Minimum	**41.86 mm (1.648 in.)**
Maximum Taper	**0.020 mm (0.0008 in.)**
Maximum Out-of-Round	**0.025 mm (0.0010 in.)**
Connecting Rod Journal OD:	
New	**38.958 - 38.970 mm (1.5338 - 1.5343 in.)**
Minimum	**38.94 mm (1.5328 in.)**
Maximum Taper	**0.012 mm (0.0005 in.)**
Maximum Out-of-Round	**0.025 mm (0.0010 in.)**
Crankshaft Total Indicated Runout (TIR):	
PTO End (In Engine)	**0.15 mm (0.0059 in.)**
Entire Crankshaft (In Bench V-Blocks)	**0.10 mm (0.0039 in.)**

Camshaft

End Play (with shims)	**0.076 - 0.127 mm (0.003 - 0.005 in.)**
Clearance	**0.025 - 0.063 mm (0.0010 - 0.0025 in.)**
Bore ID:	
New	**20.000 - 20.025 mm (0.7874 - 0.7884 in.)**
Maximum	**20.038 mm (0.7889 in.)**
Bearing Journal OD:	
New	**19.962 - 19.975 mm (0.7859 - 0.7864 in.)**
Minimum	**19.959 mm (0.7858 in.)**

Balance Shaft

End Play	**0.0575 - 0.3625 mm (0.0023 - 0.0143 in.)**
Clearance	**0.025 - 0.063 mm (0.0009 - 0.0025 in.)**
Bore ID:	
New	**20.000 - 20.025 mm (0.7874 - 0.7884 in.)**
Maximum	**20.038 mm (0.7889 in.)**
Balance Shaft Bearing Surface (Journal) OD:	
New	**19.962 - 19.975 mm (0.7859 - 7864 in.)**
Minimum	**19.959 mm (0.7858 in.)**

Cylinder Bore, Piston and Rings

Cylinder Bore ID:	
New	**90.000 - 90.025 mm (3.5433 - 3.5443 in.)**
Maximum	**90.63 mm (3.5681 in.)**
Maximum Out-of-Round	**0.12 mm (0.0047 in.)**
Maximum Taper	**0.05 mm (0.0020 in.)**
Piston-to-Cylinder Clearance	**0.031 - 0.043 mm (0.0012 - 0.0016 in.)**

ENGINE - KOHLER SPECIFICATIONS

Piston-To-Pin Clearance	**0.006 - 0.017 mm (0.0002 - 0.0007 in.)**
Piston Pin Bore ID:	
New	**19.006 - 19.012 mm (0.7483 - 0.7485 in.)**
Maximum	**19.025 mm (0.7490 in.)**
Piston Pin OD:	
New	**18.995 - 19.000 mm (0.7478 - 0.7480 in.)**
Minimum	**18.994 mm (0.7478 in.)**
Top Compression Ring-To-Groove Side Clearance	**0.060 - 0.105 mm (0.0023 - 0.0041 in.)**
Middle Compression Ring-To-Groove Side Clearance	**0.040 - 0.085 mm (0.0015 - 0.0002 in.)**
Oil Control Ring-To-Groove Side Clearance	**0.176 - 0.026 mm (0.0069 - 0.0010 in.)**
Top and Center Compression Ring End Gap:	
New Bore	**0.27 - 0.51 mm (0.010 - 0.020 in.)**
Used Bore (Maximum)	**0.77 mm (0.030 in.)**
Piston Thrust Face OD:	
New	**89.951 - 89.969 mm (3.5413 - 3.5420 in.)**
Minimum	**89.824 mm (3.5363 in.)**
Piston Thrust Face-To-Cylinder Bore Clearance:	
New	**0.031 - 0.043 mm (0.0012 - 0.0016 in.)**

Connecting Rod

Crankshaft (Big End) Clearance:	
New	**0.030 - 0.055 mm (0.0012 - 0.0022 in.)**
Maximum	**0.07 mm (0.0025 in.)**
Side	**0.18 - 0.41 mm (0.007 - 0.016 in.)**
Piston Pin Clearance	**0.015 - 0.028 mm (0.0006 - 0.0011 in.)**
Piston Pin End ID:	
New	**19.015 - 19.023 mm (0.7486 - 0.7489 in.)**
Maximum	**19.036 mm (0.7495 in.)**

Governor

Crankcase Control Arm Bore ID:	
New	**6.025 - 6.050 mm (0.2372 - 0.2382 in.)**
Maximum	**6.063 mm (0.2387 in.)**
Control Arm OD:	
New	**5.975 - 6.000 mm (0.2352 - 0.2362 in.)**
Minimum	**5.962 mm (0.2347 in.)**
Crankcase Bore-To-Control Arm Clearance	**0.025 - 0.075 mm (0.0010 - 0.0030 in.)**
Gear Shaft OD:	
New	**5.990 - 6.000 mm (0.2358 - 0.2362 in.)**
Minimum	**5.977 mm (0.2353 in.)**
Gear Shaft-To- Gear Bore Clearance	**0.015 - 0.140 mm (0.0006 - 0.0055 in.)**

Oil Pump

Relief Valve Spring Free Length	**25.19 mm (0.99 in.)**
Oil Pump Cover-to-Rotor Clearance	**0.076 mm (0.003 in.)**

Torque Specifications (Alphabetical)

NOTE: Use appropriate torque wrench which will read within the inch pound range given, or convert inch pounds to foot pounds as follows: Inch-pounds ³ 12 = Foot-pounds

Air Cleaner Base Nut	**9.9 N•m (88 lb-in.)**
Cylinder Head Cap Screw:	
Initial	**20 N•m (177 lb-in.)**
Final	**41 N•m (30 lb-ft)**
Connecting Rod Cap Screws:	
8 mm Straight Shank Bolt	**22.7 N•m (200 lb-in.)**
Step Down Shank Bolt	**14.7 N•m (130 lb-in.)**
6 mm Straight Shank Bolt	**11.3 N•m (100 lb-in.)**
Engine Mounting Cap Screws	**32 N•m (24 lb-ft)**
Fan Cap Screw	**9.9 N•m (88 lb-in.)**
Flywheel Cap Screw	**68 N•m (50 lb-ft)**
Fuel Pump/Cover Screw:	
New Installation (Thread Forming)	**9.0 N•m (80 lb-in.)**
Replacement	**7.3 N•m (65 lb-in.)**
Fuel Bowl Nut	**4.0 N•m (35 lb-in.)**
Governor Arm Clamp Nut	**10 N•m (89 lb-in.)**
Governor Control Panel Screw	**9.9 N•m (88 lb-in.)**
Ignition Module Screw:	
New Installation (Thread Forming)	**6.2 N•m (55 lb-in.)**
Replacement	**4.0 N•m (35 lb-in.)**
Muffler Nut.	**24.4 N•m (216 lb-in.)**
Oil Filter	**7.4 N•m (65 lb-in.)**
Oil Filter Drain Plug	**8.15 N•m (72.5 lb-in.)**
Oil Pan Cap Screw	**24.4 N•m (216 lb-in.)**
Oil Pressure Switch	**7.9 N•m (70 lb-in.)**
Oil Pump Cover Screw:	
New Installation (Thread Forming)	**6.2 N•m (55 lb-in.)**
Replacement	**4.0 N•m (35 lb-in.)**
PTO Clutch to Engine Mounting Cap Screw	**75 N•m (55 lb-ft)**
Rocker Arm Pivot Cap Screw	**14 N•m (124 lb-in.)**
Spark Plug	**40 N•m (30 lb-ft)**
Starting Motor Mounting Cap Screws.	**24 N•m (216 lb-in.)**
Stator Cap Screw	**4.0 N•m (35 lb-in.)**
Throttle Plate Cap Screw	**10.7 N•m (95 lb-in.)**
Valve Cover Cap Screw:	
New Installation (Thread Forming)	**10.7 N•m (95 lb-in.)**
Replacement	**7.3 N•m (65 lb-in.)**
Voltage Regulator/Rectifier	**7.3 N•m (65 lb-in.)**

Special or Required Tools

Special or Required Tools

Tool Name	Tool No.	Tool Use
Reaming Tool (7.05 mm)	D20020WI	Used to clean or size valve guides
Reaming Tool (7.25 mm)	JDG705	Used to bore oversize valve guide
Valve Spring Compressor	JDM70	Used to remove and install valve springs
Drill Bit	6.4 mm (0.25 in.)	Throttle and choke adjustment
Dial Indicator		Automatic compression relief test, valve inspection, crankshaft end play
Digital Pulse Tachometer	JT07270	Slow and/or fast idle adjustment
Photo Tachometer	JT05719	Slow and/or fast idle adjustment
Spark Plug Ground	JDM74A5	Used to prevent accidental engine starting during tests
Cylinder Leak Tester	JT035029	Cylinder leak test
U-Tube Manometer Test Kit; or, Crankcase Vacuum Test Kit	JT05697 JT03503	Crankcase vacuum check
Oil Pressure Test Adapter w/ O-ring (required only on engines without test ports) Connector Hose Assembly Coupler Gauge, 0 - 700 kPa (0 - 100 psi)	JT07262 JT05487 JT03017 JT03262 JT07034	Oil pressure test
Lapping Tool		Valve lapping

Other Materials

Other Material

Part No.	Part Name	Part Use
M79292	MPG-2® Multipurpose Grease	Apply to engine crankshaft
	SCOTCH-BRITE® Abrasive Sheets/Pads	Clean cylinder head
	Valve Guide Cleaner	Clean valve guides
	Lithium Base Grease	Pack oil seals
	Mineral Spirits	Clean armature
	Valve Lap Compound	Lap valves
TY15130 / 395	LOCTITE® Form-in-Place Gasket	Rocker arm cover mating surfaces

MPG-2® is a registered trademark of DuBois USA

SCOTCH-BRITE® is a registered trademark of the 3M Co.

LOCTITE® is a registered trademark of the Loctite Corp.

Diagnostics

Engine Will Start

CAUTION: Avoid Injury! BE AWARE! The engine may start to rotate at any time. Keep hands away from all moving parts when testing.

NOTE: To test specific electrical components, see Electrical section and refer to either Diagnostics or Tests and Adjustments for further guidance.

Symptom: Engine Will Not Crank

(1) Is battery voltage 12.4 volts or higher?

Yes - Go to next step 3.

No - Charge battery and perform no-load test. Go to next step.

(2) Is battery voltage 12.4 volts or higher?

Yes - Go to next step.

No - Replace battery.

(3) Does starter solenoid click when ignition switch is turned to START position?

Yes - Check starter motor.

No - Check electrical system.

CAUTION: Avoid Injury! DO NOT rotate engine with starter if the spark plugs are removed. Gasoline spray from the open cylinders may be ignited by ignition spark and cause an explosion or fire.

NOTE: Perform a visual inspection first to determine if battery cables are tight and not corroded and if battery is of sufficient size to turn the engine over at minimum cranking speed of 350 rpm.

Symptom: Engine Cranks But Will Not Start

(1) Is battery voltage 12.4 volts or higher?

Yes - Go to next step 3.

No - Charge battery and perform no-load test. Go to next step.

(2) Is battery voltage 12.4 volts or higher?

Yes - Go to next step.

No - Replace battery.

Symptom: Engine Cranks But Will Not Start

(3) Does fuel shutoff solenoid click when ignition switch is turned to START/RUN?

Yes - Go to next step.

No - Defective fuel shutoff solenoid, switch or wiring. See Electrical section.

(4) Does engine crank slow?

Yes - Remove spark plugs and turn the engine over by hand. Go to next step.

No - Go to step 6.

(5) Is the engine hard to turn over by hand?

Yes - Pistons or other internal components binding.

No - Starter motor defective. Repair or replace as needed.

(6) Is the choke operating properly?

Yes - Go to next step.

No - Adjust choke cable. See “Choke Cable Adjustment” on page 28.

(7) Do spark plugs have strong blue spark?

Yes - Go to next step.

No - Possible defective spark plugs, magneto shorted to ground, flywheel magnet weak, or ignition coil air gap not adjusted. See Electrical section.

(8) Are tappets adjusted properly.

Yes - Go to next step.

No - Adjust. See “Cylinder Leak Test” on page 30.

(9) Is engine getting fuel?

Yes - Check air leaner, fuel mixture, contaminated fuel, or possible stuck float needle.

No - Check fuel shutoff valve, fuel lines, fuel pump, and engine vacuum. See “Fuel Flow Tests” on page 34, or “Crankcase Vacuum Test” on page 32.

Tests and Adjustments

Throttle Cable Adjustment

Reason:

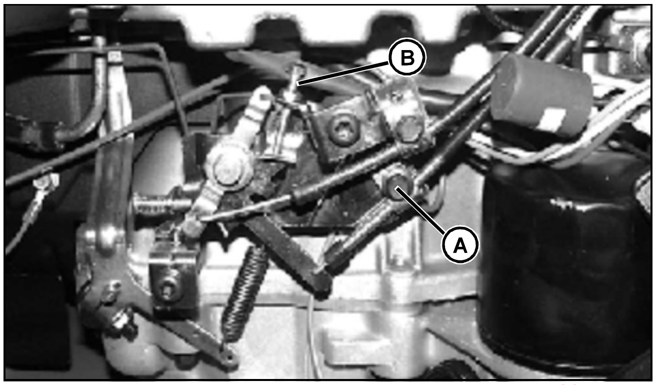
To make sure the throttle cable moves the throttle and choke control lever through its full range of movement.

Equipment:

- JT05719 Photo Tachometer; or,
- JT07270 Digital Pulse Tachometer

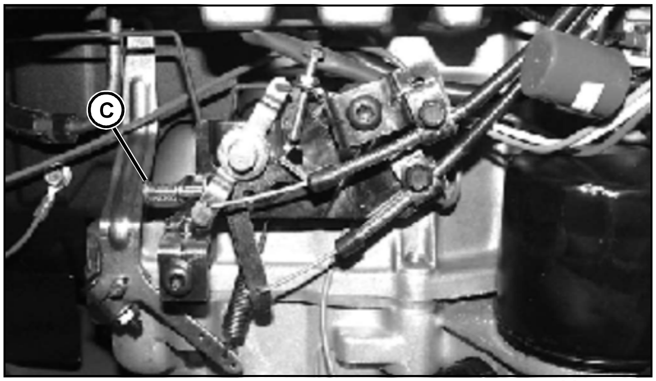
Procedure:

1. Start and run engine at MEDIUM idle for 5 minutes.
2. Loosen cable clamp (A) securing throttle cable.



M99723

3. Place throttle lever in fast idle position.
4. Adjust fast idle screw (B) until fast idle is 3350 ± 50 rpm. Pull throttle cable housing rearward to remove any slack in throttle cable.
5. Tighten throttle cable clamp.



M99722

6. Move throttle lever to the slow position.
7. Adjust slow idle screw (C) to set low idle at 1550 ± 100 rpm.
8. Move throttle lever through full range to be sure linkage is not binding.

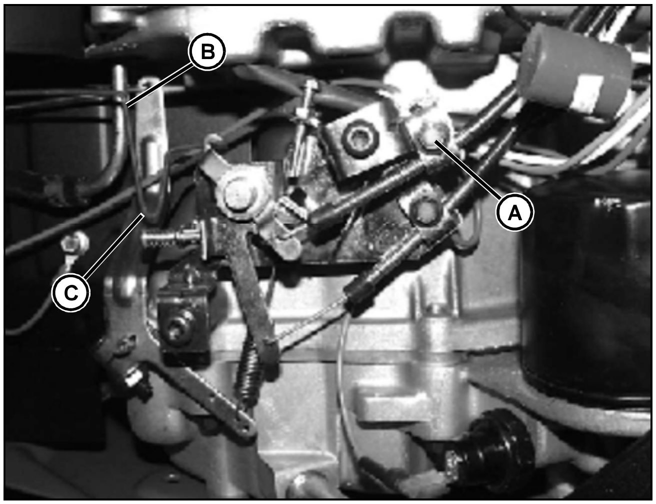
Choke Cable Adjustment

Reason:

To make sure the choke plate is fully closed when the choke lever is in the full choke position. Correct adjustment also ensures choke is completely open when the choke lever is in the OFF (choke open) position.

Procedure:

1. Stop engine and set parking brake.
2. Remove air cleaner assembly from carburetor.
3. Move choke lever to full CHOKE position.



M99724

4. Loosen choke cable clamp (A) and pull cable housing rearward to remove any slack in choke cable.
5. Tighten choke cable clamp.
6. Move throttle lever to full choke position.
7. Try to move choke rod (B) forward (choke rod should not move). If the choke rod moves forward, the choke plate is not fully closed. Carefully bend the choke rod at Vee bend (C) until the choke plate is fully closed.
8. Move choke lever to be sure choke linkage is not binding and choke plate fully opens when choke lever is in the OFF position.

Governor Adjustment

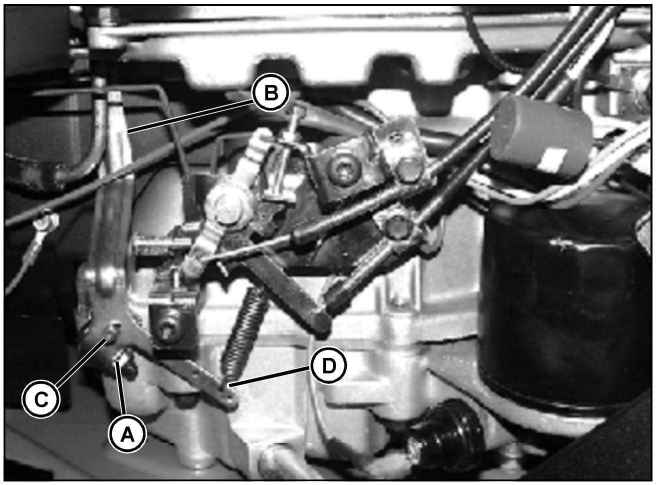
Reason:

To make sure the governor shaft contacts the fly-weight plunger when the engine is stopped.

NOTE: Adjust throttle cable before adjusting governor linkage.

Procedure:

1. Move throttle lever to FAST idle position.



M99723

2. Loosen nut (A).

3. Hold top of governor arm (B) toward carburetor. Turn governor shaft (C) counter-clockwise until it stops. Hold governor shaft and tighten nut.

4. Move throttle lever through full range to be sure linkage is not binding.

5. If governor is not responding properly, check that governor spring is in correct hole (D) in governor arm, replace spring and readjust fast idle speed. If spring did not correct the problem, repair governor.

Fast Idle Speed Adjustment

Reason:

To set engine fast idle rpm.

Equipment:

- JT05719 Photo Tachometer; or,
- JT07270 Digital Pulse Tachometer

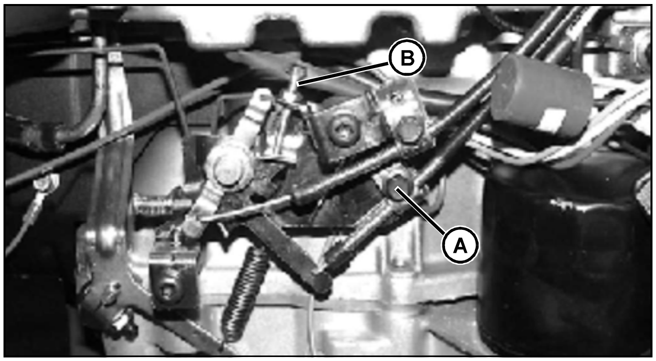
Procedure:

1. Move transaxle shift lever to NEUTRAL position. Lock park brake.

CAUTION: Avoid injury! Engine will be HOT. Be careful not to burn skin.

2. Start and run engine at MEDIUM idle for 5 minutes.

3. Loosen cable clamp (A) securing throttle cable.



M99723

4. Place throttle lever in fast idle position.

5. Adjust fast idle screw (B) until fast idle is 3350 ± 50 rpm. Pull throttle cable housing rearward to remove any slack in throttle cable.

6. Tighten throttle cable clamp.

7. Use a photo tachometer to check engine rpm at the blower housing screen; or,
use a digital pulse tachometer to check engine rpm at spark plug wire.

Specifications:

Fast Idle Speed Setting . . . . 3350 ± 50 rpm

Slow Idle Screw Adjustment

Reason:

To set engine slow idle stop screw. Slow idle is governed.

Equipment:

- JT05719 Photo Tachometer; or,
- JT07270 Digital Pulse Tachometer

Procedure:

1. Move transaxle to NEUTRAL. Lock park brake.

IMPORTANT: Avoid damage! DO NOT remove air cleaner for tests

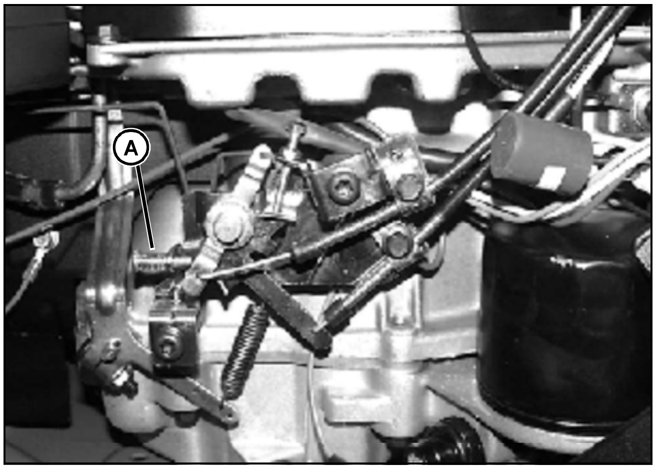
2. Put reflective tape on blower housing screen if using a photo tachometer.

3. No preliminary adjustment is required for carburetor limiter slow idle mixture screw, this is pre-set by manufacturer.

4. Start and run engine at MEDIUM idle for 5 minutes.

5. Move throttle lever to SLOW idle position.

6. Use a photo tachometer to check engine rpm at the blower housing screen; or,
use a digital pulse tachometer to check engine rpm at spark plug wire.



M99723

7. Turn slow idle stop screw (A) in either direction until specified slow idle speed is reached.

8. Move throttle between slow idle and fast idle several times. Check slow idle rpm. It may be necessary to adjust slow idle stop screw again.

Specification:

Slow Idle Stop Screw Setting . . . . .1550 ± 100 rpm

Cylinder Leak Test

Reason:

To check pressure capacity of piston rings and cylinder bore for efficient engine operation.

Equipment:

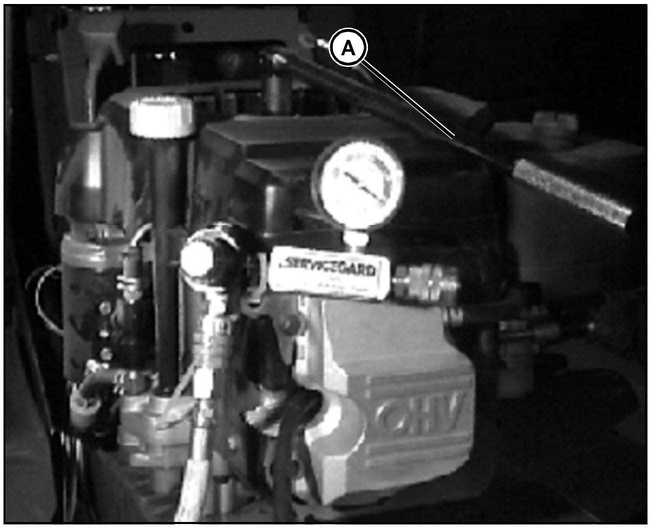
- JT035029 Cylinder Leak Tester

Procedure:

1. Remove hood.
2. Warm engine to operating temperature.

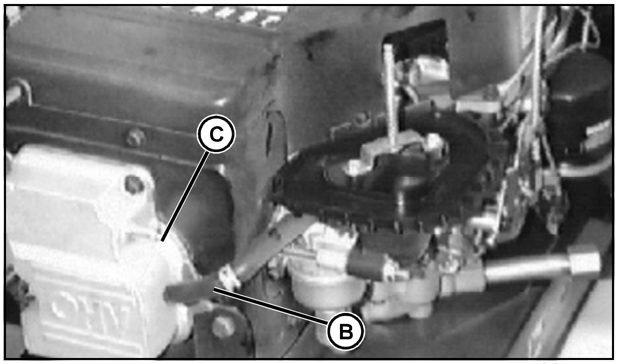
> **CAUTION: Avoid Injury! Engine will be HOT. Do not touch with bare skin, especially the exhaust pipe or muffler while performing test.**

3. Move transaxle shift lever to NEUTRAL. Lock park brake.



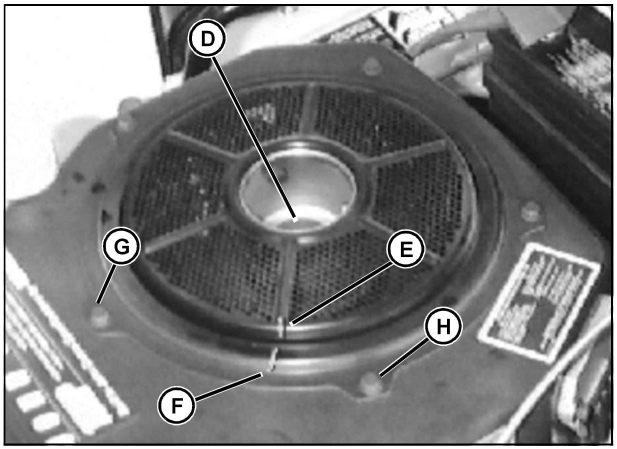
M89073

4. Pry off the flywheel screen, and use a breaker bar (A) on the flywheel nut to hold the flywheel in position when performing the test.



M85621

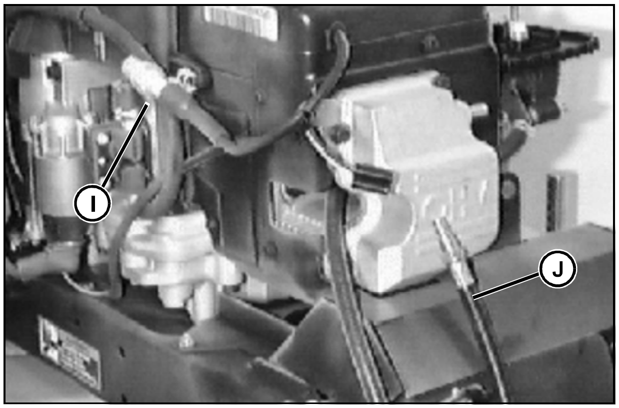
5. Disconnect crankcase breather hose (B) from valve cover breather port (C) and remove air cleaner element from engine so you can listen for air leaks.



M85624

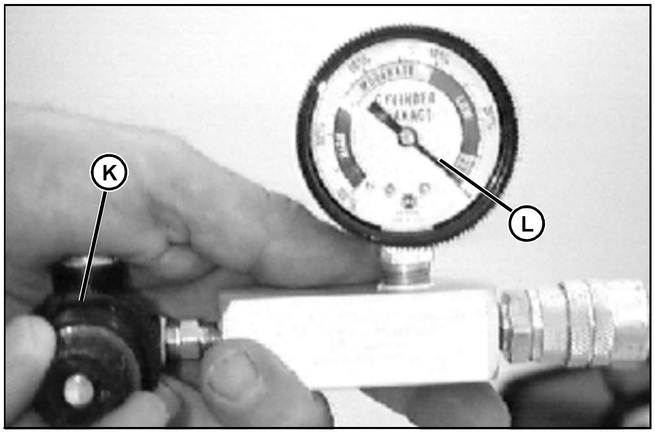
6. Use flywheel mounting cap screw (D) to turn flywheel and find approximate top dead center (TDC) of the compression stroke.

7. Remove spark plug and put a wooden dowel on top of piston to find actual TDC of the compression stroke. Then mark flywheel screen rib (E) and shroud (F) as shown between front (G) and left (H) shroud cap screws.



M85622

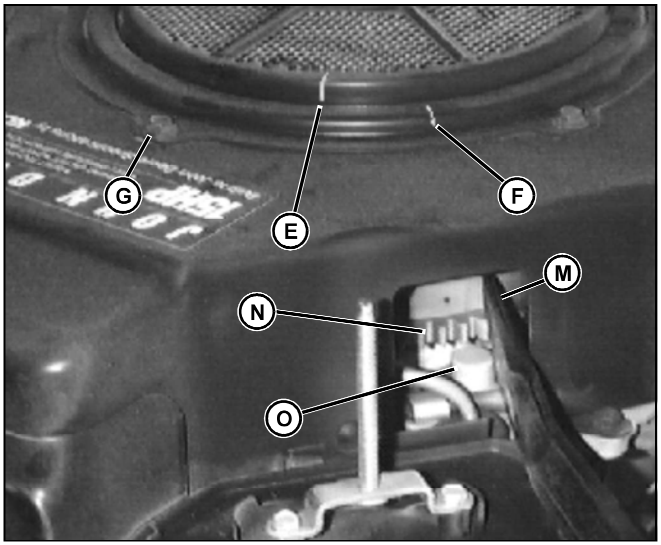
8. Ground ignition high tension lead using JDM-74A-5 Ignition Test Plug (I) to protect ignition system and install test kit adapter hose (J) into spark plug hole.



M85623

9. First turn regulator knob (K) on tester OFF (fully counterclockwise) then attach appropriate air source to coupler below black regulator valve.

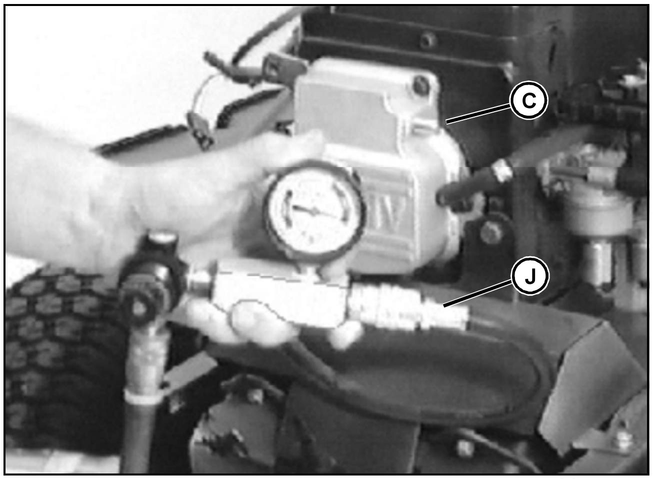
10.Gradually turn regulator knob clockwise until needle aligns with “zero” of the yellow “SET” scale (L).



M85625

11.Turn flywheel clockwise until screen TDC mark is between shroud TDC mark and front cap screw.

IMPORTANT: Avoid damage! Have a helper put a wide blade pry bar (M) between two flywheel teeth (N) and up against engine block post (O) and firmly wedge the pry bar against edge of shroud opening. This must be done properly to prevent piston and crankshaft from turning in a clockwise direction when compressed air is applied.



M85626

12.Connect adapter hose (J) to tester. Watch and record gauge reading while listening for excessive air leaks at carburetor intake, crankcase breather port, and exhaust outlet. Pressure should hold steady or reduce only slightly and only a faint air leak should be heard at the breather port.

NOTE: A slight air leak from the breather port (C) is normal as air escapes from the crankcase through the oil drainback hole in the head and breather valve.

13.Remove test equipment and install spark plug. Tighten spark plug to 40 N•m (30 lb-ft).

14.Install hood.

Results:

Leakage should not exceed 25%, if so, listening at the carburetor (intake valve), oil filler (piston rings) or muffler (exhaust valve) for escaping air will provide clues as to where to investigate for problems.

Air Leaks - Carburetor:
slight . . . . “low-to-moderate” wear to intake valve
excessive. . . . . intake valve bad, fix or replace
Air Leaks - Crankcase Breather:
slight (normal). . . . . ok
excessive. . . . . rings or cylinder wall bad,
. . . . replace rings and hone cylinder,
. . . . . .or replace short block
Air Leaks - Exhaust Outlet:
slight . . . . “low-to-moderate” wear to intake valve
excessive. . . . . .exhaust valve bad, fix or replace
Gauge Color Codes -
Green (low) . . . . compression good
Yellow (moderate). . . . . compression borderline
Red (high) . . . . .compression bad

Automatic Compression Release (ACR) Check

Reason:

To determine if the automatic compression release is opening the exhaust valve.

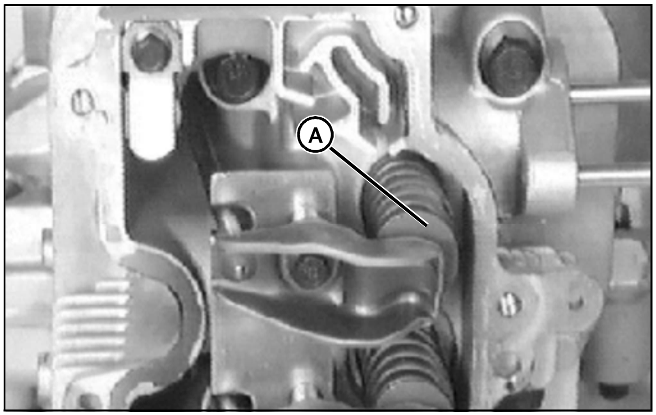
Equipment:

- JDM-74A-5 Ignition Test Plug
- Dial Indicator

Procedure:

1. Remove valve cover and spark plug and use JDM-74A-5 Ignition Test Plug to ground high tension lead to protect ignition system while turning flywheel.
2. Use flywheel mounting cap screw to turn flywheel clockwise until intake valve opens fully.
3. Slowly turn flywheel clockwise further to observe that the automatic compression release mechanism (ACR) on camshaft is functioning:

- Exhaust valve (A) must begin to open as the intake valve is nearing its closed position,
- Exhaust valve must continue to open for a distance after the intake valve is fully closed,
- Exhaust valve must return to its fully closed position as the flywheel is turned clockwise further.



M55859

- Use a dial indicator on flat of spring washer to measure exhaust valve ACR movement.
- Repeat Steps 2 and 3 to measure exhaust valve ACR minimum movement.
- Remove dial indicator and install rocker cover.
- Remove test plug and install spark plug. Tighten spark plug to 40 N•m (30 lb-ft).

Specification:

Exhaust Valve ACR Movement
Minimum . . . . 0.76 - 1.02 mm (0.030 - 0.040 in.)

Results:

- If the exhaust valve does not open or depress properly, the automatic compression release tab is faulty and camshaft assembly must be replaced. See “Camshaft Removal and Installation” on page 51.

Crankcase Vacuum Test

Reason:

To measure the amount of crankcase vacuum to ensure the crankcase is not pressurized. A pressurized crankcase will force oil to leak past the seals and through the breather into the carburetor.

Equipment:

- JT05697 U-Tube Manometer Test Kit; or,
- JT03503 Crankcase Vacuum Test Kit

Procedure Using JT05697 U-Tube Manometer:

IMPORTANT: Avoid damage! Test must be run with the engine at normal operating temperature, if not, test will be inaccurate. DO NOT use more than 3 feet of manometer tubing. If a longer hose is used the readings will be inaccurate.

1. Park machine on level surface.

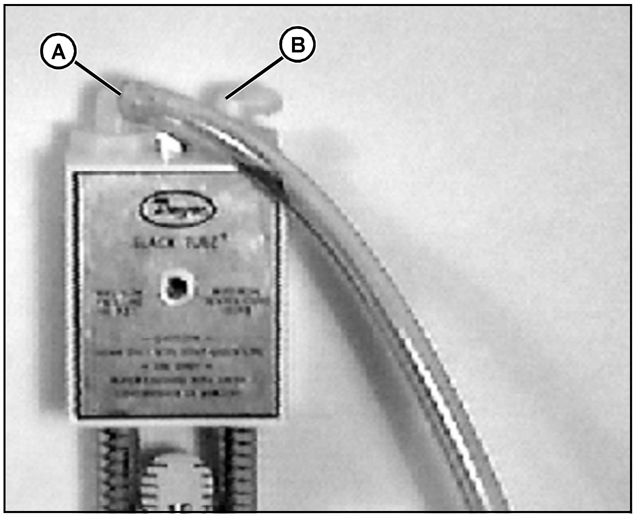
2. Raise engine hood and remove dipstick. Check dipstick/ oil fill cap and O-ring for cracks or damage, replace as necessary.

3. Install appropriate size rubber plug in dipstick tube.

4. Insert barbed fitting in rubber plug so that clear line to fitting (A) can be connected at a later step.

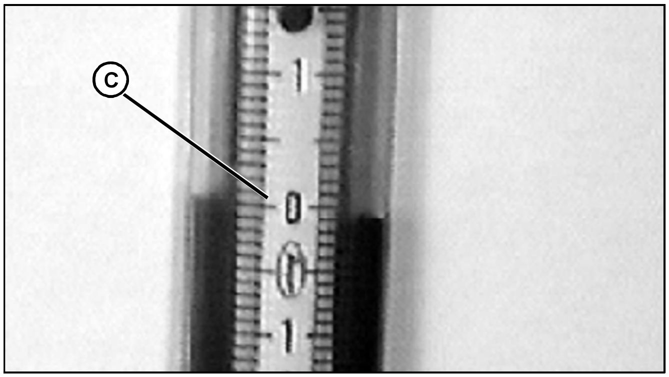
IMPORTANT: Avoid damage! DO NOT make connection between U-Tube Manometer clear line and engine crankcase BEFORE engine is running or fluid in manometer could be drawn into crankcase. DO NOT turn engine OFF until clear line has ben disconnected from U-Tube Manometer.

5. Attach manometer magnets to a solid metal surface.



M88761

6. Open top valves (A) and (B) one turn.

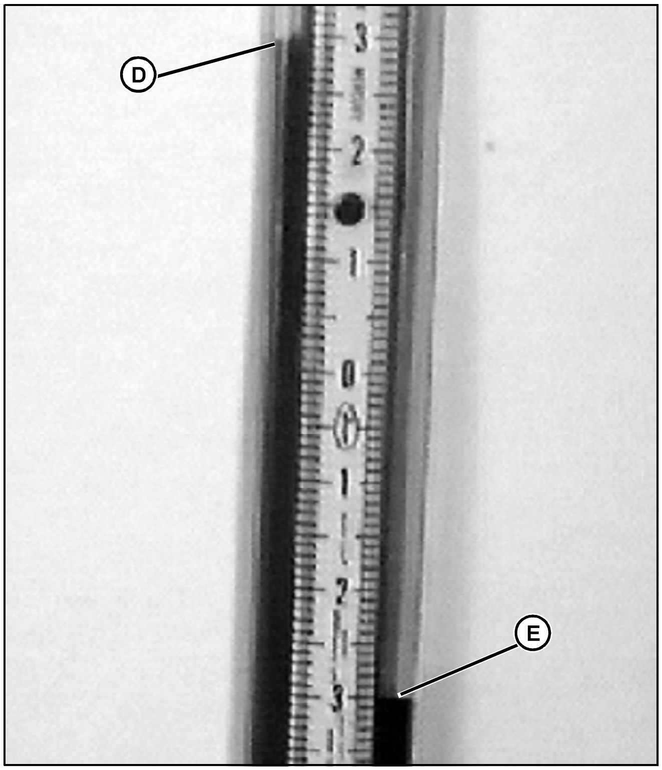


M88762

7. Zero out the manometer by sliding the ruled scale up or down so “0” (C) is located where water level on both sides is even.

8. Hold finger over rubber plug hole to keep oil from spraying out. Start engine, move the throttle lever to fast idle (3350 rpm) and allow engine to reach operating temperature.

9. Quickly attach clear line from manometer to rubber plug in dipstick opening.



M88764

Picture Note: Example: 3 + 3 = 6 in. of vacuum

10.Record vacuum reading. Gauge should show a minimum vacuum of 10.2 cm (4.0 in.) of water movement. The reading is obtained by adding (D) and (E) water movement from “0” position.

IMPORTANT: Avoid damage! Repeat test at least three times for accuracy. To repeat test, remove the manometer tube from top of manometer at “D”. DO NOT remove manometer tube from engine. Perform step #7 then reattach manometer tube to side “D”. Continue with step #10.

11.Remove line from manometer before stopping engine.

12.Stop engine then remove dipstick hose connection and install dipstick.

Procedure Using JT03503 Crankcase Vacuum Kit:

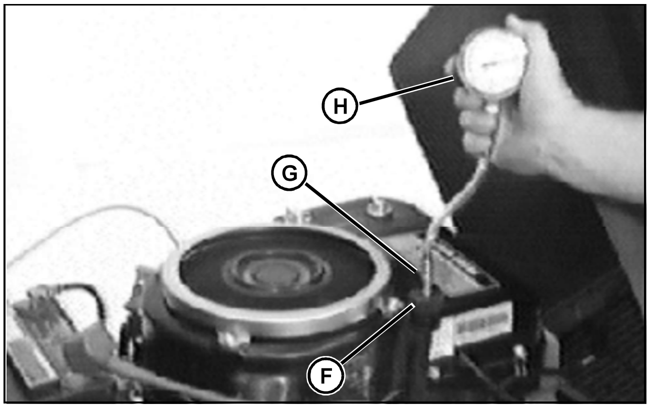
1. Park machine on level surface.

2. Raise engine hood and remove dipstick. Check dipstick/ oil fill cap and O-ring for cracks or damage, replace as necessary.

3. Install appropriate size rubber plug (F) in dipstick tube.

4. Insert barbed fitting (G) in rubber plug so that clear line to fitting (A) can be connected at a later step.

IMPORTANT: Avoid damage! DO NOT make connection between test gauge (H) and rubber plug BEFORE engine is running at FAST idle or gauge damage may result.
After test reading is made, DO disconnect test gauge WHILE engine is running at FAST idle to prevent damage to gauge.



M85637

5. Hold finger over rubber plug hole to keep oil from spraying out. Start engine, move the throttle lever to fast idle and allow engine to reach operating temperature.

6. Connect gauge, clear line, and barbed fitting to rubber plug.

7. Record crankcase vacuum reading. Gauge should show a minimum vacuum of 10.2 cm (4.0 in.).

8. Disconnect barbed fitting, clear line, and gauge from rubber plug while engine is running at FAST idle. Hold finger over rubber plug hole to keep oil from spraying out.

9. Move throttle to SLOW idle and turn engine OFF.

10.Remove rubber plug and install dipstick.

Specification:

Minimum Crankcase Vacuum
at 3350 rpm . . . . 10.2 cm (4.0 in. water)

NOTE: A new engine may have low vacuum readings due to the fact that the rings are not seated.

Results:

If crankcase vacuum does not meet specification, check the following:

- Breather reed valve clearance and condition.
- Seals and gaskets for leakage.
- Rocker arm cover O-ring for leakage.
- Valves and valve seats for wear or damage.
- Head warp.
- Rings, piston, and cylinder bore for wear or damage.

Fuel Flow Tests

Reason:

To determine fuel pump pressure and flow to the carburetor.

Test Equipment:

- JDG356 Pressure Gauge
- JDM-74A-5 Ignition Test Plug
- Graduated Container

Procedure:

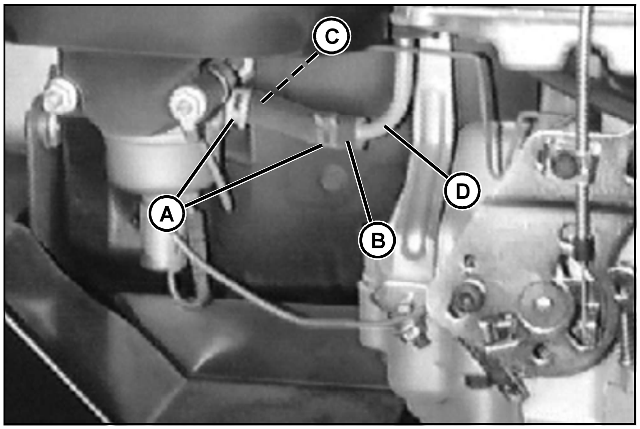
1. Park machine on level surface.

2. STOP engine and allow to cool.

3. Check for sufficient volume of fuel in tank to perform test.

4. Disconnect spark plug wire and ground it with a JDM-74A-5 Ignition Test Plug. This prevents damage to ignition system while cranking engine during test.

⚠ **CAUTION: Avoid injury! Gasoline is extremely flammable. DO NOT SMOKE. Always work in a well ventilated area away from open flame or spark producing equipment; including equipment that utilizes pilot lights.**

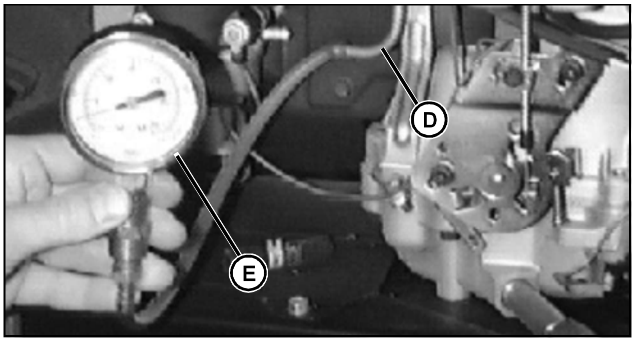


M85604

5. On left side of engine, put a shop cloth below carburetor inlet to soak up any escaping fuel.

6. Slide fuel line clamps (A) to right off the hose.

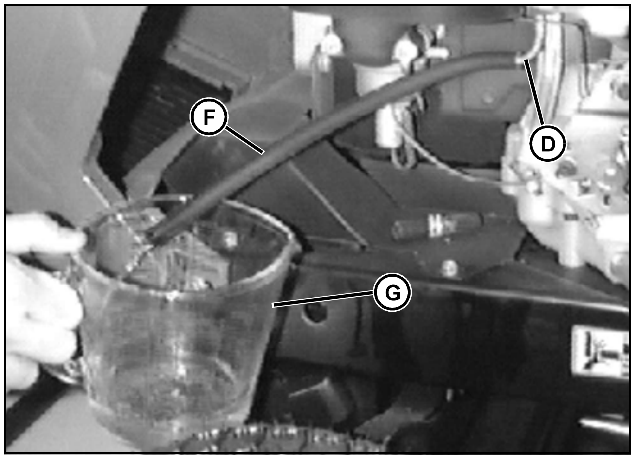
7. Disconnect hose (B) from carburetor inlet tube (C) and metal fuel line (D), respectively. Wipe up any spilled fuel immediately.



M85605

8. Connect JDG356 Pressure Gauge (E) hose to metal fuel line.

9. Crank engine for 3 - 5 seconds only. Record pressure, minimum pressure should be 6.12 kPa (0.90 psi). Turn key switch OFF.



M85606

10.Remove pressure test equipment and install a long piece fuel hose (F) onto metal fuel line (D) and a large graduated beaker (G).

11.Crank engine for 15 seconds only; otherwise, starter may be damaged. Record flow, minimum flow should be 30 ml (1.0 U.S. oz).

12.Remove test equipment, reconnect hose to metal fuel line then carburetor inlet tube, fasten with fuel line clamps, and reconnect spark plug lead.

Results:

- If fuel pump pressure and flow DO meet specifications, check carburetor inlet tube, inlet needle, and float for proper function, obstructions, varnish/sticking conditions, or other problems. See “Air Intake System Components” on page 37, and “Carburetor Inspection” on page 38.
- If fuel pump pressure or flow DO NOT meet specifications, check fuel lines, in-line filter, fuel tank, pickup tube, and fill cap vent for restrictions and retest.
- If after retest, fuel pump pressure or flow DO NOT meet specifications, replace fuel pump.

Oil Pressure Test

Reason:

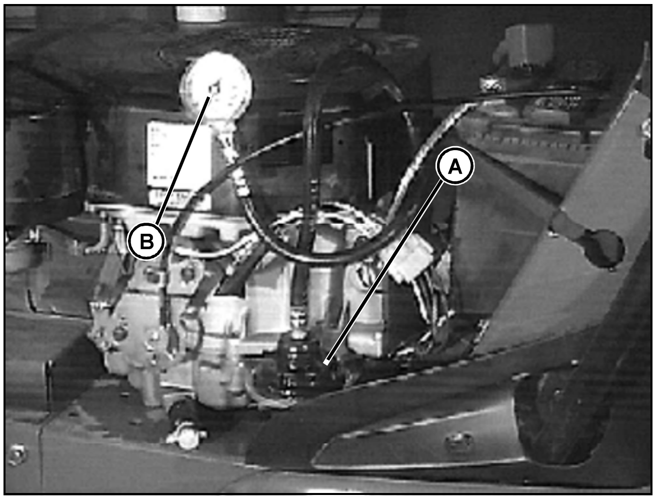
To verify that the engine has enough oil pressure to lubricate the internal engine components.

Equipment:

- JT07262 Oil Pressure Test Adapter w/ O-ring (required ONLY on engines without test ports)
- JT05487 Connector
- JT03017 Hose Assembly
- JT03262 Coupler
- JT07034 Gauge, 0 - 700 kPa (0 - 100 psi)

NOTE: The connector, hose assembly, coupler, and gauge are found in other SERVICEGARD™ test kits. The connector pipe thread (NPT) also matches the oil pressure switch port on early Kohler engines.

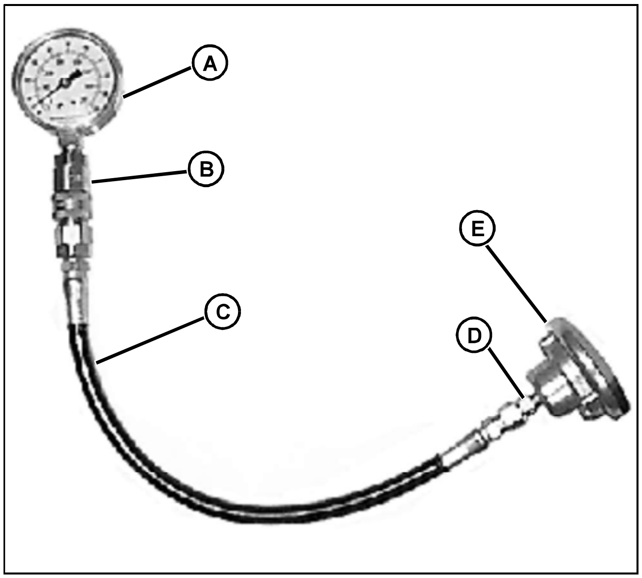
Procedure:



M89105

1. Perform test procedure with engine level.
2. Stop engine.
3. Disconnect spark plug wire and allow engine to cool.
4. Drain engine oil from oil filter.
5. Remove oil filter and wipe filter base clean.
6. Install pre-assembled adapter (A), connector, hose assembly, coupler, and gauge (B) on to oil filter base. ONLY hand-tighten adapter to oil filter base.

7. Check crankcase oil level and adjust to full mark.



A - JT07034 Gauge
B - JT03262 Coupler
C - JT03017 Hose Assembly
D - JT05487 Connector
E - JT07262 Oil Pressure Adapter w/ O-Ring

8. Monitor oil pressure during cranking, if oil pressure is below 28 kPa (4 psi) - STOP engine immediately and correct cause before continuing.

9. Connect spark plug wire.

10. Warm-up engine by running at MEDIUM idle for five minutes.

CAUTION: Avoid injury! Engine components are HOT. DO NOT touch with bare skin. Wear protective eye glasses and clothing.

11. Record oil pressure readings at SLOW and FAST idle.

12. Stop engine and allow to cool.

13. Remove adapter, connector, hose assembly, coupler, and gauge.

14. Install new oil filter.

15. Run engine for 30 seconds and stop engine.

16. Check crankcase oil level and adjust to full mark.

Results:

- If oil pressure readings are not within 69 - 517 kPa (10.0 - 75.0 psi) at FAST idle, inspect and/or replace the following:

-Oil pump assembly. See “Oil Pump Relief Valve Inspection” on page 50.

-Oil suction screen

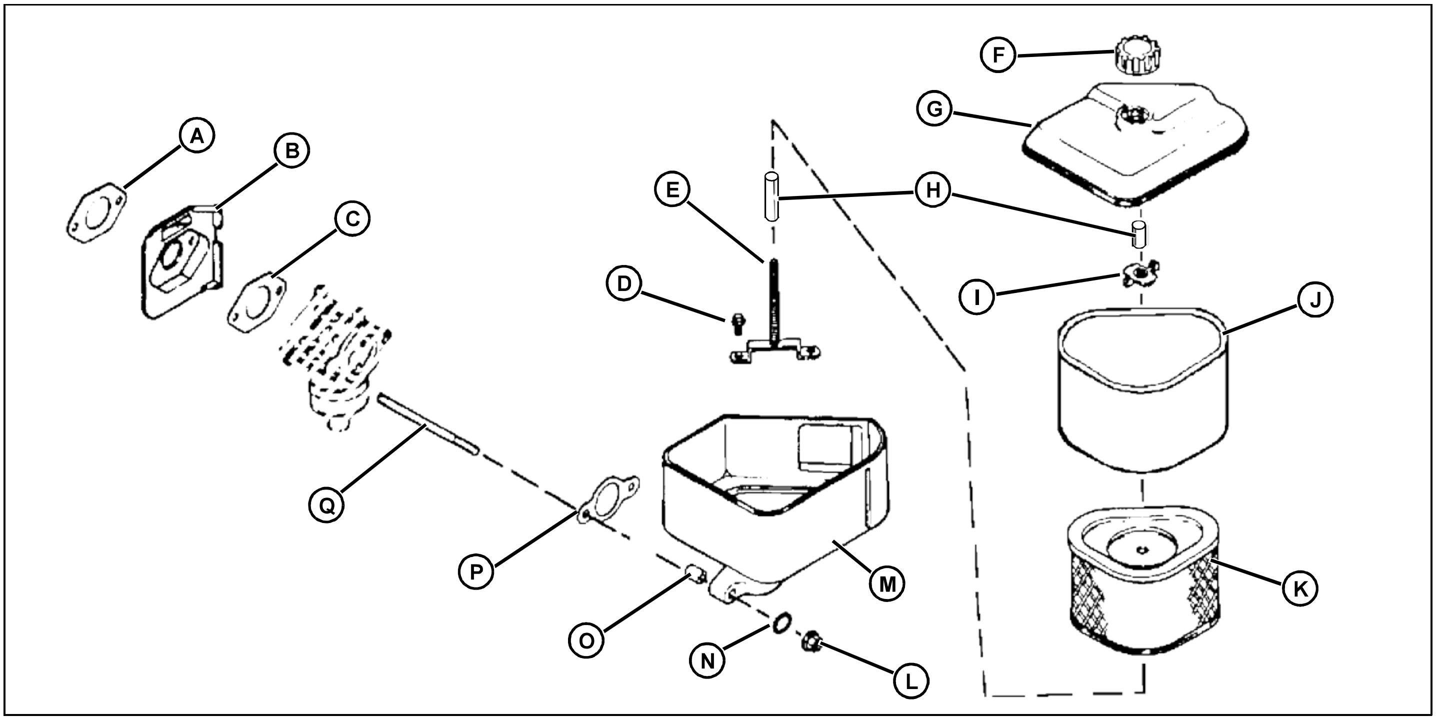
-Oil passages

-Bearing wear

-Oil Seals

Fuel and Air Repair

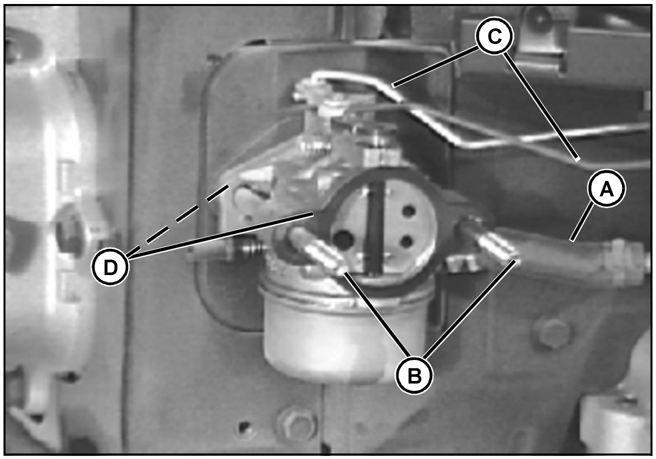
Air Intake System Components



M55326

- A - Gasket
- B - Shield
- C - Gasket
- D - Stud Retaining Screw (Use Thread-Lock & Sealer)
- E - Stud (Remove studs to remove carburetor)
- F - Knob
- G - Cover
- H - Rubber Seal
- I - Wing Nut
- J - Foam Element
- K - Paper Element
- L - Nut (Tighten to 9.9 N•m (88 lb-in.))
- M - Air Cleaner Housing
- N - Washer (Used on stud w/o electrical eyelet of grounding lead)
- O - Sleeve
- P - Gasket
- Q - Stud

Carburetor Removal and Installation



M89099

CAUTION: Avoid Injury! Gasoline is extremely flammable. DO NOT SMOKE. Always work in a well ventilated area away from open flame or spark producing equipment; including equipment that utilizes pilot lights.

Procedure:

1. Turn ignition switch OFF and disconnect battery negative (-) ground cable.

2. Disconnect fuel shut-off solenoid wire.

3. Pinch fuel line (A) to block fuel flow then disconnect fuel line.

4. Remove air filter assembly (see above) and carburetor, DO NOT damage threads of studs (B).

5. Disconnect linkage rods (C) from carburetor levers.

6. Remove and discard gaskets (D), install new ones.

7. Connect linkage rods and install carburetor, studs, and air filter assembly. Tighten nuts, securing carburetor and air cleaner assembly, to specification.

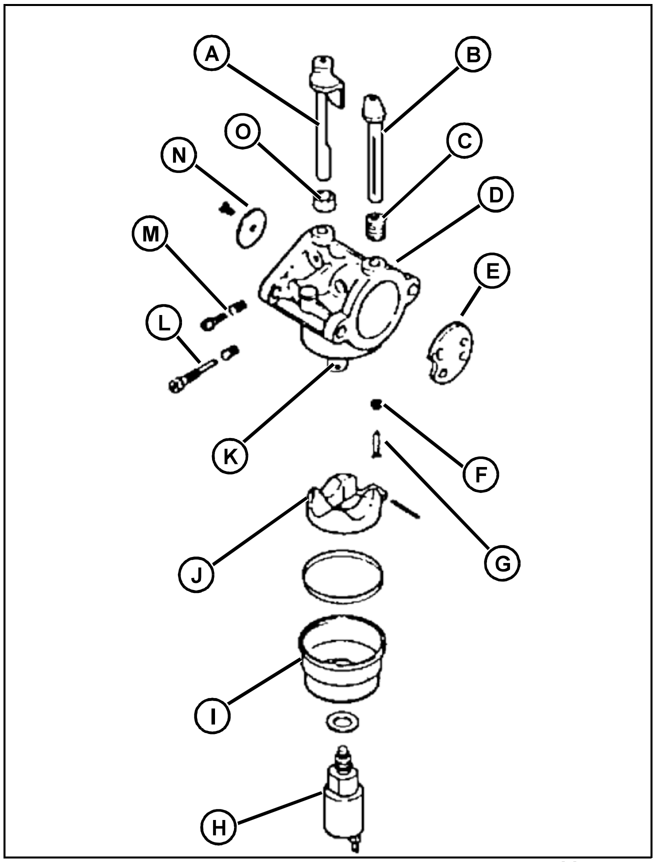
8. Connect fuel line and remove clamp from line.

9. Adjust carburetor. See “Tests and Adjustments” on page 28.

Torque Specification:

Air Cleaner Assembly Nuts . . . . 9.9 N•m (88 lb-in.)

Carburetor Inspection



M52127

A - Throttle Shaft
B - Choke Shaft
C - Choke Spring
D - Body
E - Choke Plate
F - Inlet Seal
G - Needle
H - Fuel Shut-Off Solenoid (Optional)
I - Float Bowl
J - Float
K - Main Jet
L - Fuel Screw
M - Idle Screw
N - Throttle Plate
O - Seal

CAUTION: Avoid Injury! Gasoline is extremely flammable. DO NOT SMOKE. Always work in a well ventilated area away from open flame or spark producing equipment; including equipment that utilizes pilot lights.

Procedure:

1. Disassemble bowl, float, inlet needle, low idle mixture screw and spring.

IMPORTANT: Avoid damage! Further disassembly of carburetor is not required for general cleaning. Further disassembly will require replacing parts with new parts. DO NOT soak carburetor in carburetor cleaner when fiber, rubber or foam gaskets are still installed. Cleaner may damage these components.

2. Clean carburetor using pressurized carburetor cleaner and compressed air. Clean out all passages.

3. DO NOT remove idle port welch plug unless absolutely necessary. To remove, pierce with sharp tool. Clean chamber. Install new plug using a flat tool about the same size as plug. Flatten plug but do not force below the surface of the cavity.

4. If inlet seat was leaking or damaged it can be replaced by pulling it out with a drill bit or screw. Always replace with new parts. Press in new seat until it bottoms in bore.

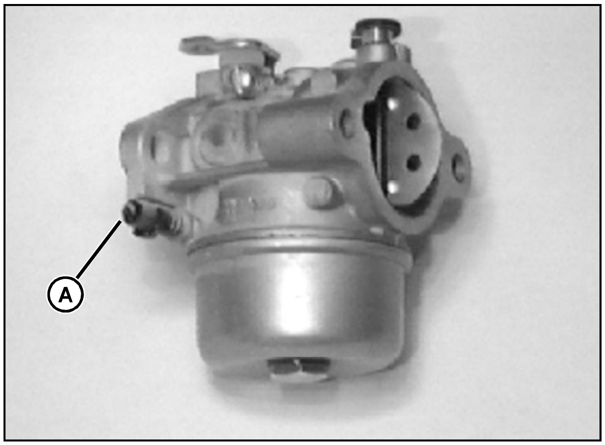
5. If throttle and choke plates were removed, use a high strength thread lock and sealer on the small retaining screws. Install screws slightly loose. Apply pressure on shafts to center plates in bore, then tighten screws.

NOTE: High altitude jet is available.

6. Main jet can be pressed out. Replace with new jet. Press new jet in until flush with surface.

7. Low idle mixture screw has a precision taper. If screw is grooved, bent or broken, this may indicate seat damage and carburetor may need to be replaced.

8. On standard carburetors, to set preliminary adjustment for idle mixture screw - turn clockwise until LIGHTLY seated and back-out (counterclockwise) one full turn.



Picture Note: New Emissions Carburetor

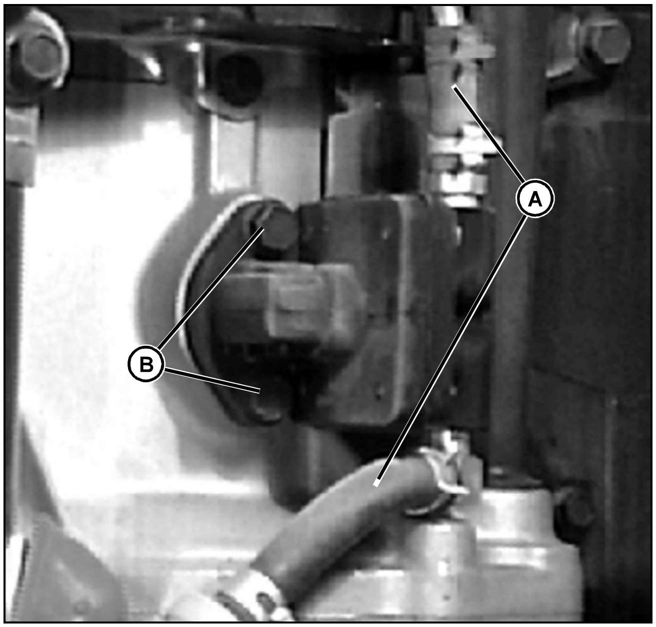
9. On new emissions carburetors, no preliminary adjustment is required for idle mixture screw (A), this is pre-set by manufacturer - only turn screw (limited to maximum 1/4 turn in either direction) until specified slow idle speed is obtained.

10. Perform slow idle adjustment. See “Slow Idle Screw Adjustment” on page 29.

Fuel Pump Removal and Installation

Procedure:

1. Clamp fuel line shut.



2. Disconnect fuel lines (A).
3. Remove bolts (B) from fuel pump.
4. Install components in reverse order of removal.

Torque Specifications:

New installation (Thread forming)	**9.0 N•m (80 lb-in.)**
Replacement	**7.3 N•m (65 lb-in.)**

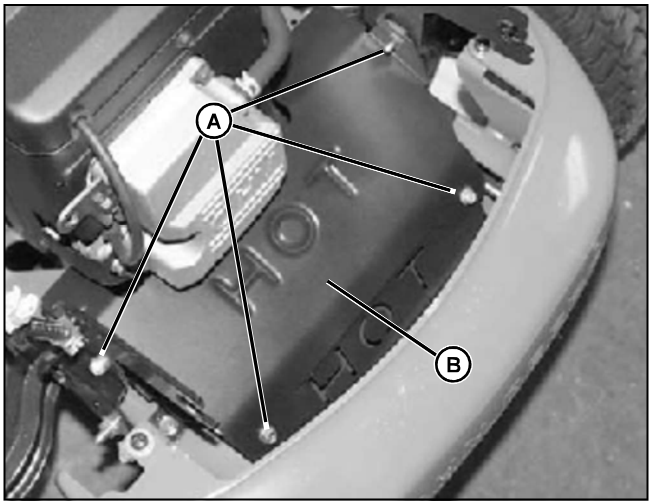
Engine Repair

Engine Removal and Installation

Removal:

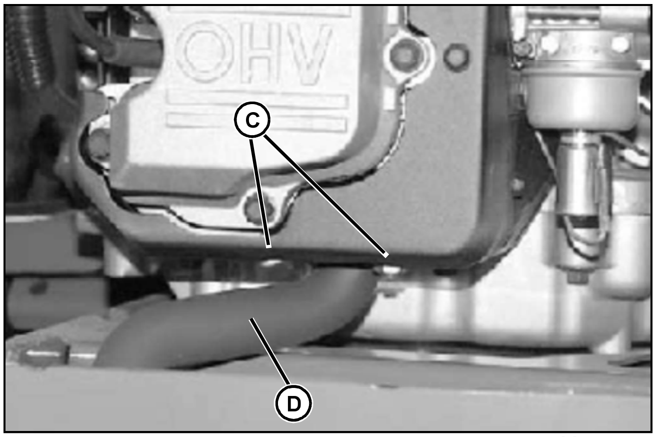
CAUTION: Avoid Injury! ROTATING BLADES/ MOVING PARTS. STOP engine. Remove ignition key. Wait for all moving parts to STOP.

1. Park machine on a hard, level surface. Lock parking brake.
2. Open the hood.
3. Disconnect battery negative (-) cable from the battery.
4. Remove hood. See “Hood Removal and Installation” on page 589 in the Miscellaneous section.



M95517

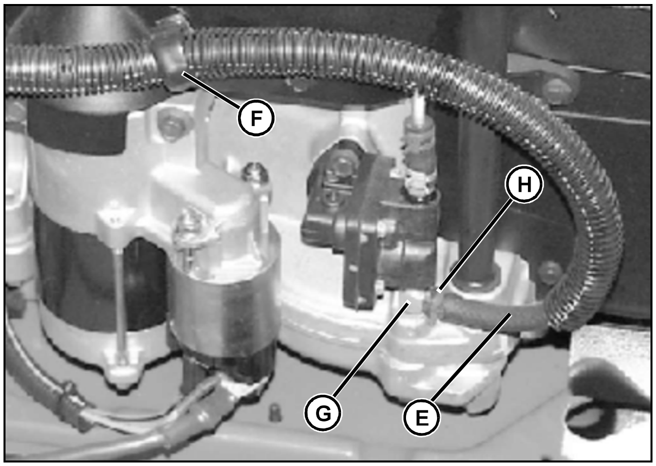
5. Remove four cap screws (A) and upper muffler heat shield (B).



M95525

6. Remove two lock washers and nuts (C) securing the muffler exhaust tube (D) to the cylinder head.

CAUTION: Avoid Injury! Gasoline is extremely flammable. DO NOT SMOKE. Always work in a well ventilated area away from open flame or spark producing equipment; including equipment that utilizes pilot lights.

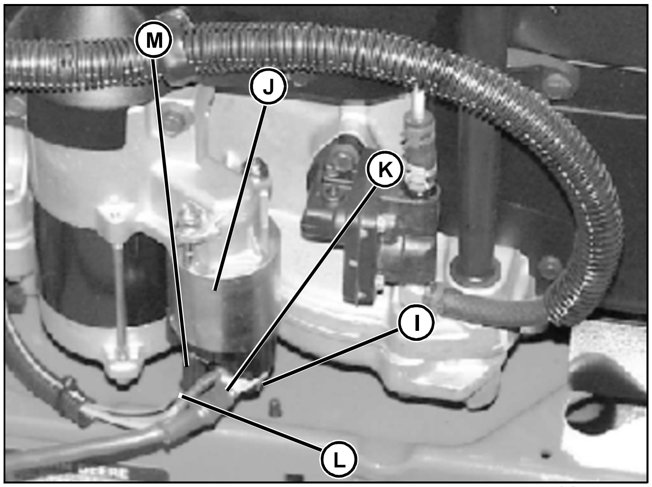


M99571

7. Disconnect fuel hose (E) from J-clamp (F).

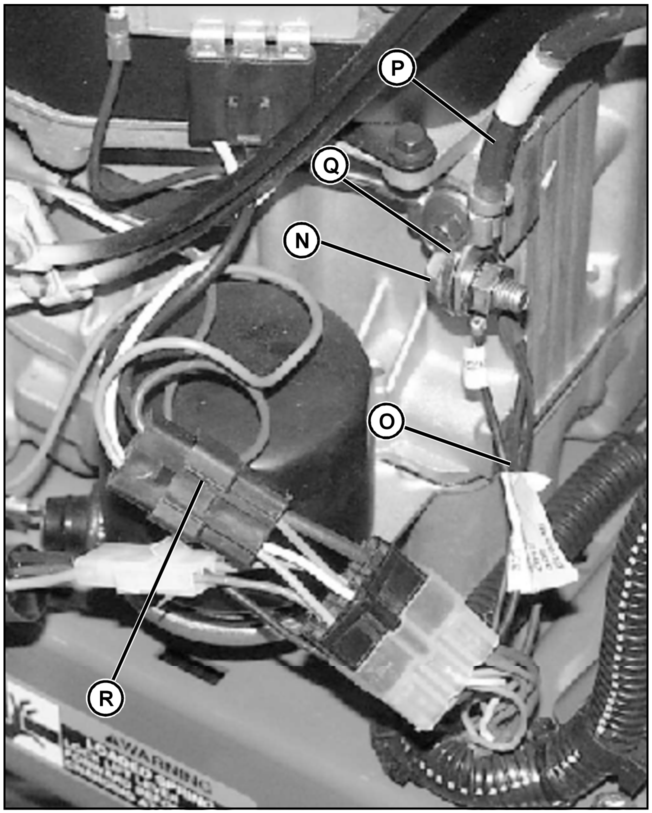
NOTE: Fuel may come out of fuel line when it is disconnected from the engine fuel pump. Have a suitable container ready to catch draining fuel and prevent spillage.

8. Disconnect fuel hose from fuel pump elbow (G) by removing clamp (H). Plug end of fuel hose or raise end of hose above level of fuel tank to prevent fuel drainage.



M99571

9. Remove nut and lock washer (I) from bottom of start motor solenoid (J).
10. Disconnect positive (+) battery cable (K) and charging wire (L) from solenoid.
11. Disconnect key switch connector (M) from solenoid.

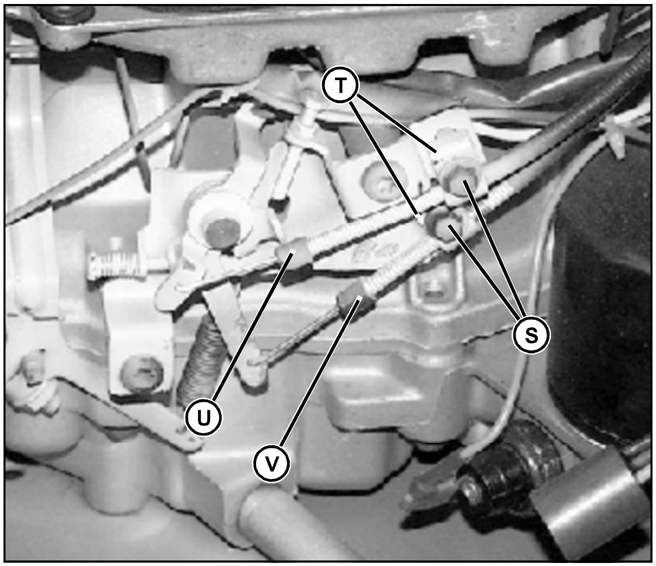


M99572

NOTE: Left closeout panel removed for clarity.

12.Remove cap screw and nut (N), and disconnect ground wires (O) and battery negative (-) cable (P) from engine ground bracket (Q).

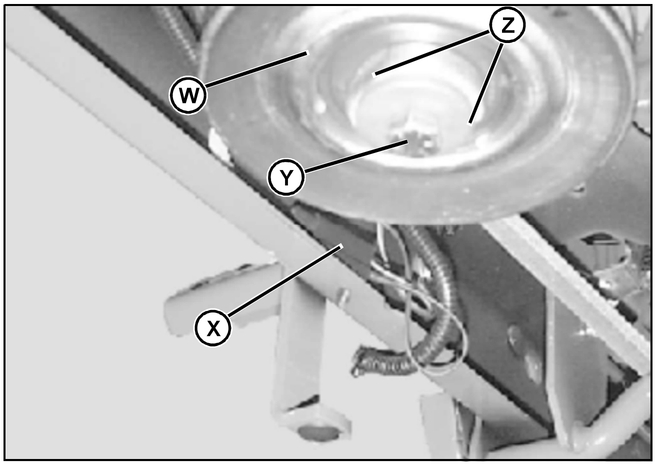
13.Disconnect wiring harness electrical connector (R) from engine.



M99573

14.Loosen screws (S) on two clamps (T), and disconnect throttle (U) and choke cables (V) from engine.

15.On underside of machine, locate the traction drive belt tensioner. Using a pry bar, turn belt tensioner to relieve tension on belt, and slip belt off of flat idler.



M95555

16.Disconnect PTO clutch (W) electrical connector (X).

NOTE: PTO clutch and traction drive sheave will fall off when cap screw and washer (Y) are removed.

17.Remove cap screw and washer attaching PTO clutch and traction drive sheave to engine crankshaft. If necessary, hold flats (Z) on PTO clutch with a wrench to prevent engine crankshaft from turning.

18.Remove PTO clutch. See “Electric Clutch Removal and Installation” on page 347 in Electrical section.

19.Remove drive sheave.

20.Remove four cap screws securing engine.

⚠ **CAUTION: Avoid Injury! Engine weighs approximately 36 kg (80 lbs). Use a suitable hoist or obtain assistance when removing engine.**

21.Remove engine from machine frame.

Installation:

Installation is the reverse of removal.

1. Clean muffler flange and engine mating surfaces of any old gasket material. Install a new muffler gasket.
2. Install engine to machine frame.
3. Tighten engine mounting cap screws to 32 N•m (24 lb-ft).
4. Tighten muffler mounting nuts to 24.4 N•m (216 lb-in.).

NOTE: If the engine has been rebuilt (cylinder rebored or deglazed, etc.), break-in oil should be used for the first five hours (maximum) of operation.

5. Fill engine to proper level with oil of correct specifications. See “4 - Cycle Gasoline Engine Oil” on page 15 in Specifications section.

6. Apply DuBois MPG-2, Multi-Purpose Grease - M79292 to engine crankshaft before installing engine drive sheave and PTO clutch.

7. Slip traction drive belt into groove of traction drive sheave.

8. Install traction drive sheave to engine crankshaft with thicker hub side toward engine.

9. Rotate traction drive sheave to align keyways on engine crankshaft and drive sheave. Install square key into slots.

10. Install PTO clutch to engine crankshaft. Be sure clutch properly engages welded anti-rotation pin on machine frame. Retain with cap screw and washer. Be sure washer is installed with cup side toward PTO clutch. Tighten cap screw to 75 N•m (55 lb-ft).

11. Connect PTO clutch wiring harness connector.

12. Install muffler flange lock washers and nuts.

13. Attach choke and throttle cables to engine controls. Retain with mounting clamps and screws.

14. Attach battery negative (-) cable and ground wires to engine ground bracket.

15. Connect engine wiring harness connector.

16. Attach battery positive (+) cable and charging wires to engine start motor solenoid terminal.

17. Attach key switch wire to engine start motor solenoid.

18. Attach fuel line to fuel pump fitting. Retain with hose clamp.

19. Attach fuel line to engine J-clamp.

20. Install muffler heat shield. Retain with four cap screws.

21. Rotate tensioner assembly with a suitable pry bar to extend spring. Slip traction drive belt on to flat idler.

22. Attach negative (-) cable to battery.

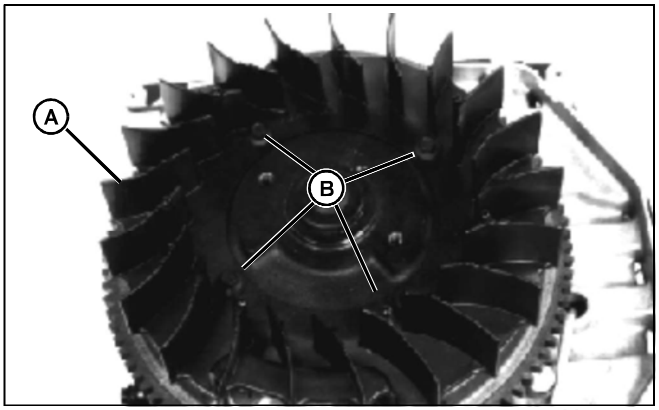
23. Adjust throttle cable. See “Throttle Cable Adjustment” on page 28.

24. Install hood.

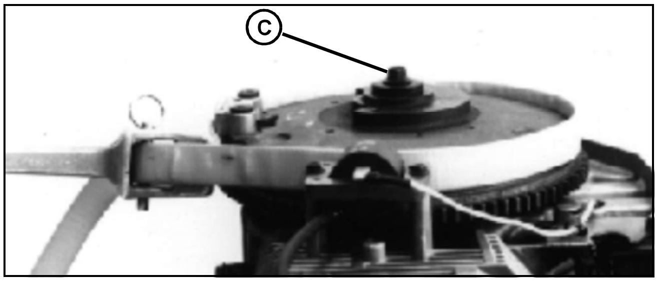
Flywheel Removal and Installation

Procedure:

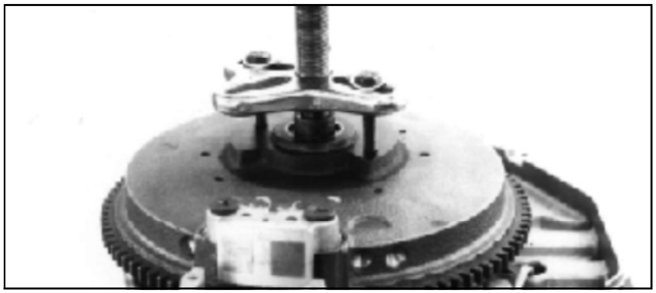
1. Remove blower housing sheet metal.



2. Remove four fan cap screws and washers (B) and fan (A).



3. Hold flywheel with strap wrench. Remove cap screw (C).



4. Remove flywheel using a puller.

NOTE: Flywheel and magnets are not serviceable.

5. Inspect flywheel for cracks, chips, and broken teeth. Replace as necessary.

6. Inspect for sheared or partially sheared key, replace as necessary.

IMPORTANT: Avoid damage! Check that crankshaft end and flywheel hub are clean and free of lubricant, and flywheel key is installed properly in keyway. Improperly installed flywheel can cause machine damage and serious personal injury.

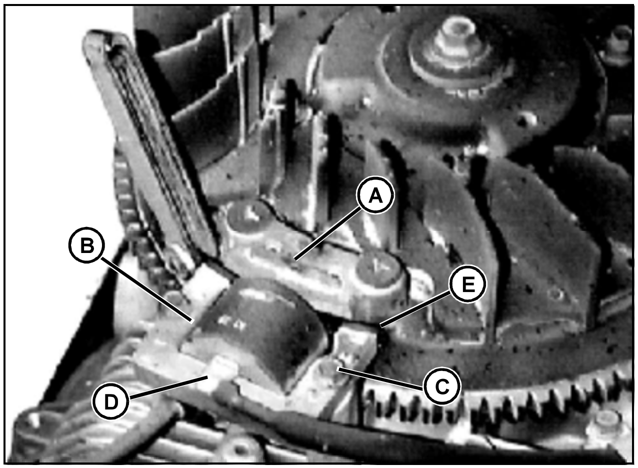
7. Install flywheel and key on crankshaft.

8. Hold flywheel with strap wrench. Tighten cap screw (C) to specification.

9. Check ignition module air gap.

Ignition Module Air Gap:

1. Turn flywheel magnet (A) away from ignition module (B).
2. Loosen module cap screws (C).
3. Disconnect ignition wire (D) from ignition module.



M58360

4. Place 0.25 mm (0.010 in.) feeler gauge blade (E) or shim stock across magnet face.
5. Align flywheel magnet (A) with mounting posts for ignition module.

> **IMPORTANT: Avoid damage! Ensure flywheel magnet is centered on ignition module so all three poles of the ignition module are properly gapped from the flywheel magnet.**

6. Tighten cap screws to specification.
7. Remove feeler gauge and connect wire (D) to terminal.

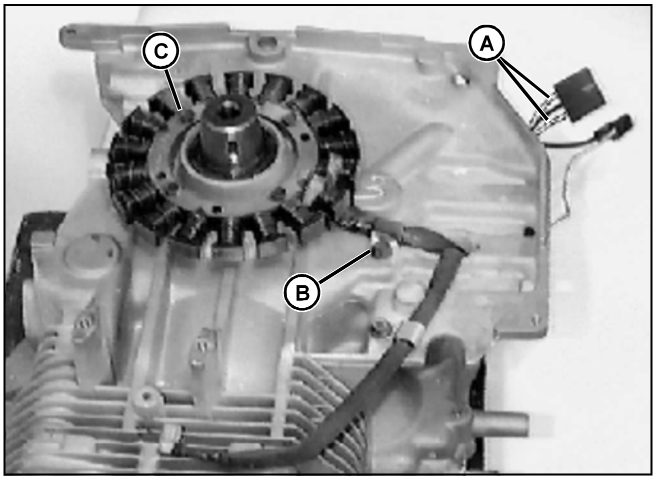
Specifications:

Ignition Module Air Gap	**0.25 mm (0.010 in.)**
Module Cap Screws	**4.0 N•m (35 lb-in.)**
Stator Cap Screws	**4.0 N•m (35 lb-in.)**
Flywheel Cap Screw	**68 N•m (50 lb-ft)**
Fan Cap Screws	**9.9 N•m (88 lb-in.)**

Stator Removal and Installation

Procedure:

1. Remove ignition module.
2. Remove flywheel.



M58361A

3. Remove two white stator wires (A) from connector.
4. Remove clamp (B).
5. Remove four cap screws (C) and stator.
6. Inspect for damage.

Installation is done in the reverse order of removal.

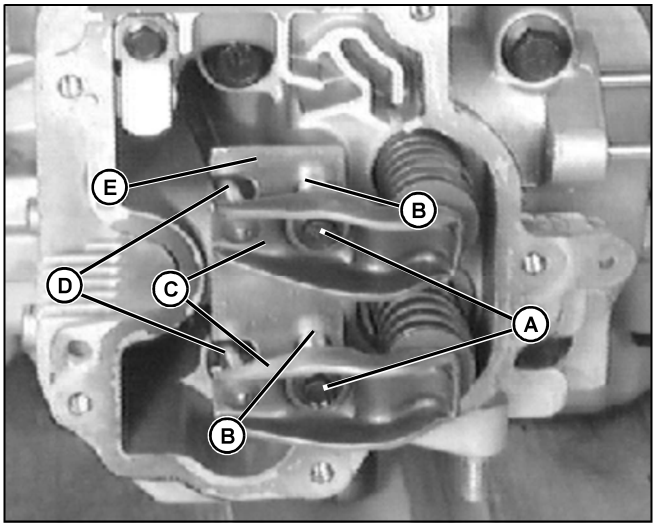
- Tighten four cap screws to 4.0 N•m (35 lb-in.).
- Install armature-with coil loosely. DO NOT tighten cap screws.
- Adjust armature air gap. See “Ignition Module Air Gap:” on page 43.

Rocker Arms Removal and Installation

Procedure:

1. Remove valve cover.

IMPORTANT: Avoid damage! Mark push rods for assembly in original locations.

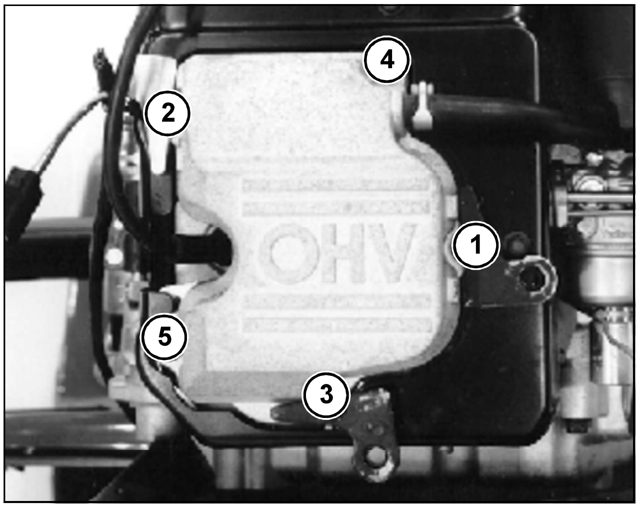


M55859

2. Remove cap screws (A) and pivot ball spacers (B).
3. Remove rocker arms (C).
4. Remove push rods (D).
5. Remove splash plate (E).
6. Inspect and replace components as necessary.
7. Clean mating surfaces of any sealant residue.

Installation is in reverse order of removal.

- Apply TY15130 John Deere Form-In-Place Gasket to mating surfaces.



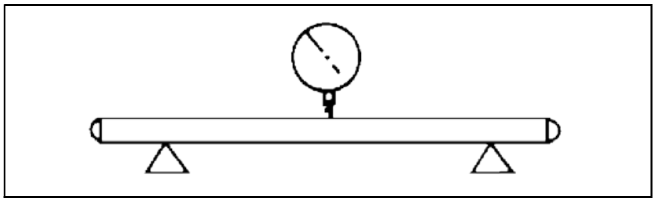
M83660

- Tighten rocker arm cap screws, in sequence illustrated, to specifications.

Specifications:

Rocker Arm Pivot Cap Screws . . . . . 14 N•m (124 lb-in.)
Push Rod Bend (maximum) . . . . . . 0.76 mm (0.030 in.)

Inspect Push Rod



M50044

- Inspect push rod for bend using V-blocks and a dial indicator. Turn rod slowly and read variation on indicator. Replace if variation is greater than 0.76 mm (0.030 in.).

Cylinder Head Removal and Installation

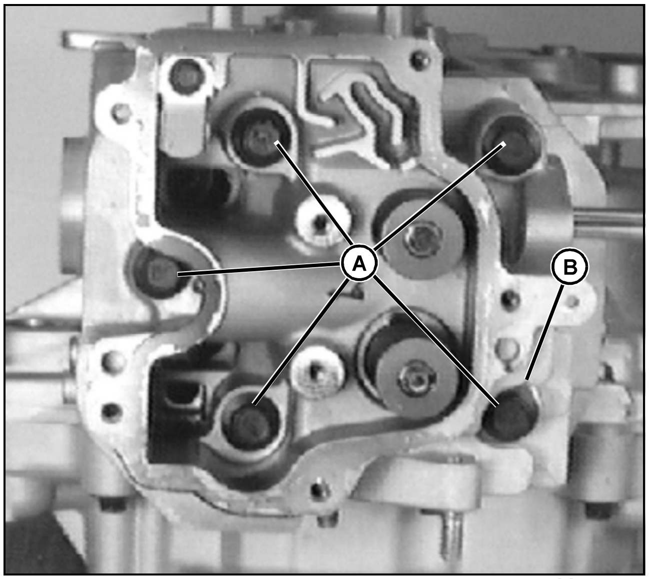
Procedure:

IMPORTANT: Avoid damage! Engine must be cold before removing cap screws to avoid warping aluminum cylinder head.

NOTE: Cylinder head can be serviced without removing engine from machine.

1. Remove blower housing.
2. Remove rocker arms. See “Rocker Arms Removal and Installation” on page 44.
3. Remove spark plug.

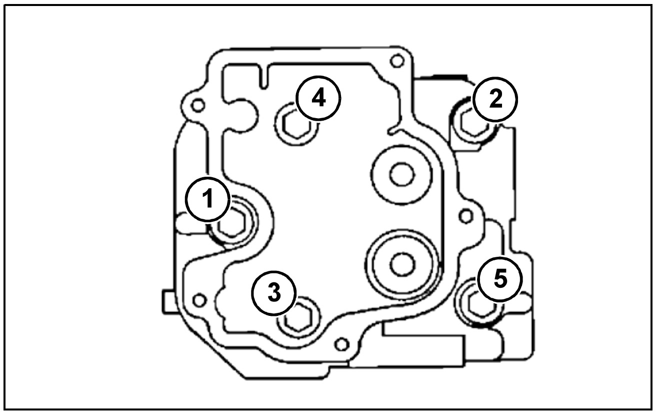
IMPORTANT: Avoid damage! Loosen cylinder head cap screws (A) 1/4 turn at a time to avoid warping the head.



M55861

4. Remove cap screws (A), spacer (B) and cylinder head. Discard gasket. Clean head and block.

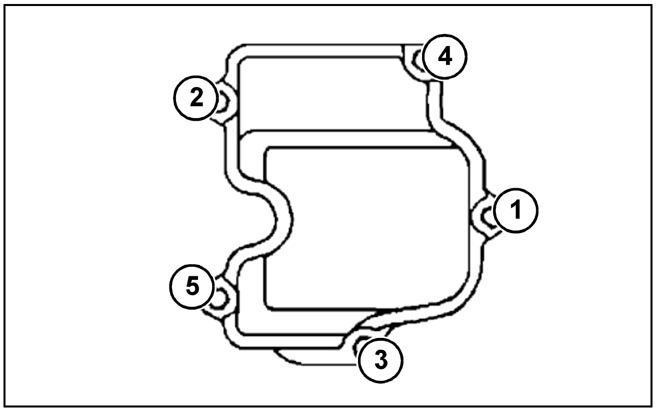
5. Install new gasket with cylinder head, cap screws and spacer. Following tube instructions, apply an approved room temperature vulcanizing (RTV) silicone sealant to bottom surface of bolt heads.



M52074

6. Tighten cylinder head cap screws in **7 N•m (62 lb-in.)** increments in sequence illustrated, to **41 N•m (30 lb-ft)**.

7. Install push rods and rocker arms.



M52075

8. Clean valve cover and install using RTV silicone sealant between mating surfaces. Tighten valve cover cap screws, in sequence illustrated.

9. Install spark plug. Tighten spark plug to 40 N•m (30 lb-ft).

10.Install blower housing.

Torque Specifications:

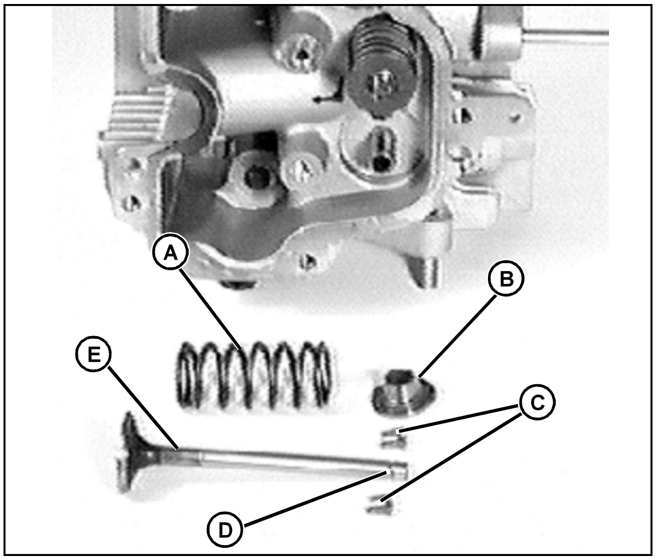
Cylinder Head Cap Screws . . . . 41 N•m (30 lb-ft)

Rocker Arm Pivot Cap Screws . . . . . 14 N•m (124 lb-in.)

Valve Cover Cap Screws . . . . 7.3 N•m (65 lb-in.)

Valves and Springs Removal and Installation

Procedure:



M55867

1. Compress intake and exhaust springs using an appropriate size spring compressor.

2. Remove keepers (C), spring caps (B), springs (A), and valves (E).

3. Install valve components.

IMPORTANT: Avoid damage! Make sure keepers (C) are seated in valve stem groove (D).

4. Compress spring (A) and install keepers (C) in grooves (D).

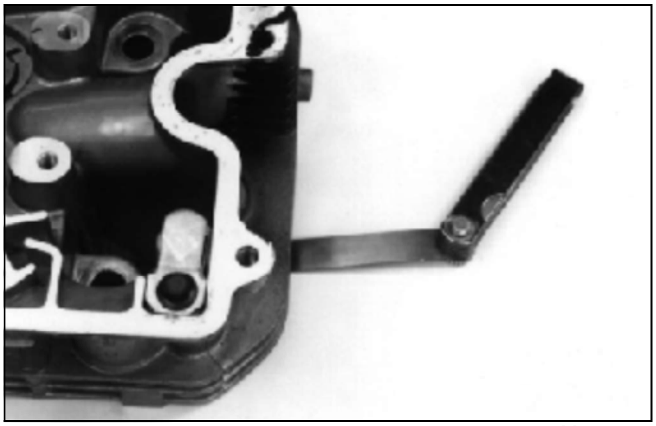
5. Install rocker arm assembly and cylinder head in reverse order.

Cylinder Head Inspection

Procedure:

1. Remove carbon deposits and clean gasket surface with SCOTCH-BRITE® abrasive or equivalent.

2. Inspect head for cracks or damage. Make sure oil drain port is open.



M52080

3. Put head on a flat surface plate. Check for distortion at several points with a feeler gauge. Replace head if distorted beyond specification.

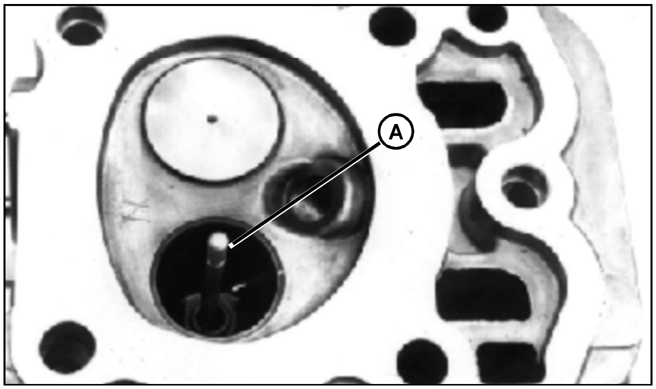
Specification:

Cylinder Head Warp (maximum) . . 0.076 mm (0.003 in.)

Valve Guides:

NOTE: Valve guides cannot be replaced, but if worn can be reamed to 0.25 mm (0.010 in.) oversize. Replace cylinder head if guides are worn beyond oversize wear limit.
If guides have been reamed, oversized valves must be installed.

1. Clean inside of valve guide. Standard valve guide reamer (D20020WI) can be used.



M52081

2. Measure inside diameter of guide with gauge (A).

IMPORTANT: Avoid damage! If guide is reamed oversized, an oversize valve must be installed.

3. If valve guide is worn beyond standard wear limit, ream guide using JDG705 Oversize Reaming Tool. If guide is worn beyond oversize wear limit, replace cylinder head.

Valve Guide ID Specifications:

Intake Guide:

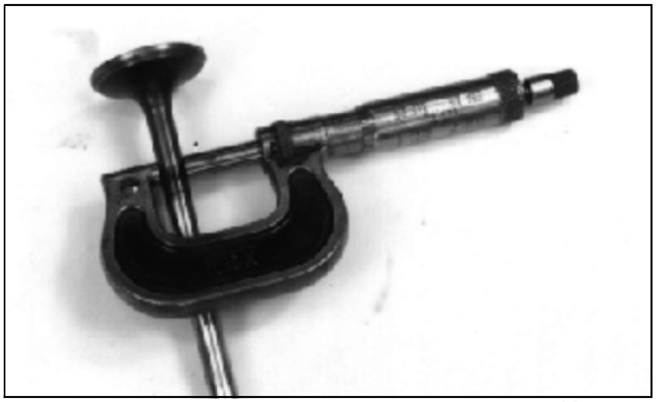
Standard	**7.038 - 7.058 mm (0.277 - 0.278 in.)**
Standard (Wear Limit)	**7.134 mm (0.281 in.)**
Oversize	**7.288 - 7.308 mm (0.287 - 0.288 in.)**
Oversize (Wear Limit)	**7.384 mm (0.291 in.)**

Exhaust Guide:

Standard	**7.038 - 7.058 mm (0.277 - 0.278 in.)**
Standard (Wear Limit)	**7.159 mm (0.282 in.)**
Oversize	**7.238 - 7.308 mm (0.285 - 0.288 in.)**
Oversize (Wear Limit)	**7.409 mm (0.301 in.)**

4. Remove carbon from valve head, face, and stem with a power-operated wire brush. Be sure carbon is removed, not merely burnished.

NOTE: An 0.25 mm (0.010 in.) oversize is available.



M52082

5. Measure outside diameter of valve stem at several points wear stem moves in guide.

Valve Stem OD Specifications:

Intake Valve:
Standard . . . . 6.982 - 7.000 mm (0.275 - 0.276 in.)
Oversize. . . . . 7.232 - 7.250 mm (0.284 - 0.285 in.)

Exhaust Valve:
Standard . . . . 6.970 - 6.988 mm (0.274 - 0.275 in.)
Oversize. . . . . 7.220 - 7.238 mm (0.284 - 0.285 in.)

6. Subtract valve stem OD (use largest OD) from valve guide ID to find valve stem-to-guide clearance. Replace valve if stem-to-guide clearance is too great.

Valve Stem-to-Guide Clearance:
Intake . . . . 0.038 - 0.076 mm (0.0015 - 0.003 in.)
Exhaust . . . . 0.050 - 0.088 mm (0.0020 - 0.0035 in.)

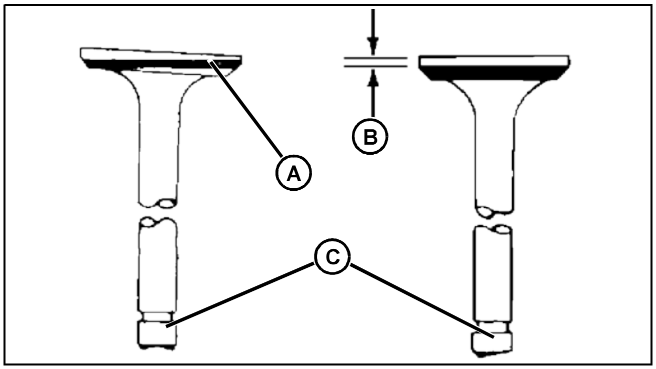
Valves Inspection

Special or Required Tools:

- Dial Indicator

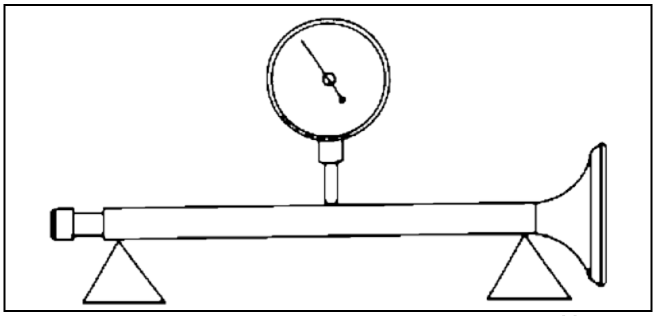
Procedure:

1. Remove carbon from valve head, face, and stem with a power-operated wire brush. Be sure carbon is removed, not merely burnished.
2. Check valve for cracks or damage. Replace if needed.



M38087

3. Replace warped valves (A) or valves with less than serviceable margin (B). Valve stem ends (C) should be square, not worn uneven as shown.



M51753

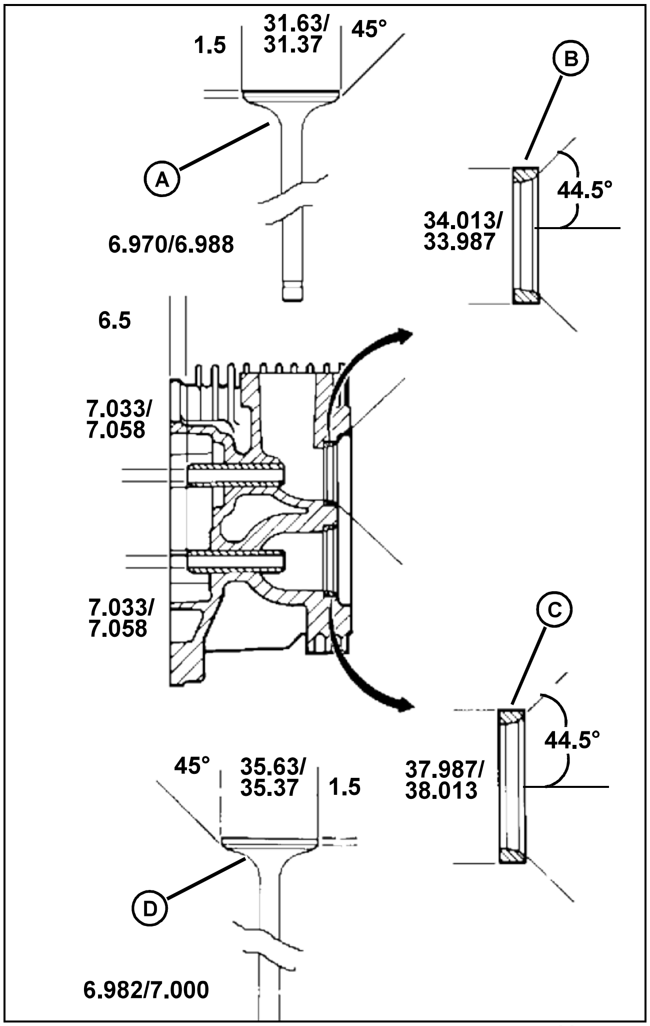
4. Inspect valve stems for bends using V-blocks and dial indicator. Turn valve slowly and read variation. Replace if variation is greater than specification.

Specification:

Valve Stem Bend (maximum) . . . . 0.076 mm (0.003 in.)
Valve Margin (minimum) . . . . 1.5 mm (0.059 in.)

Valve Seats Recondition

Procedure:



M55939

A - Exhaust Valve
B - Exhaust Insert
C - Intake Insert
D - Intake Valve

1. Inspect valve seats.
2. Replace cylinder head if seats are warped or distorted beyond reconditioning.
3. Reface pitted or worn seats as shown in drawing. Cut valve seating to specification.
4. Lap valves after refacing.
5. Check seat for good contact using Prussian Blue Compound.

Specification:

Valve Seat Angle	**44.5°**
Valve Face Angle	**45°**

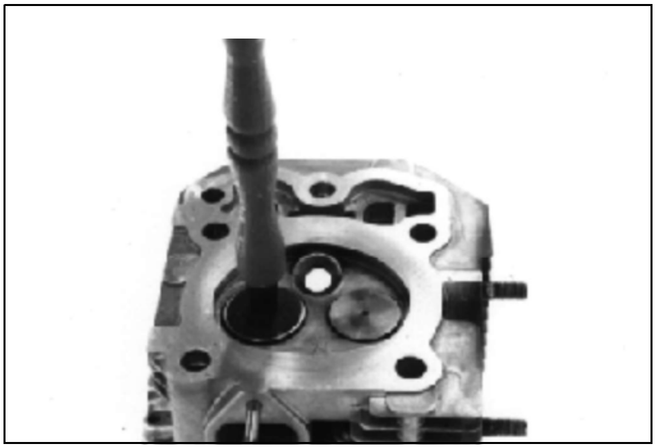
Lap Valves

Special or Required Tools:

- Lapping Tool

Procedure:

> **IMPORTANT: Avoid damage! Valves and seats should be lapped if they do not make good contact.**

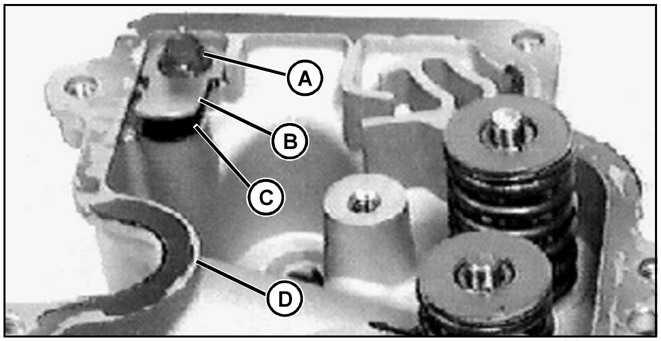


M52134

1. Apply light coat of lapping compound to valve face, then turn valve in seat using vacuum cup tool.
2. Check valve every 8 strokes until a uniform ring appears around surface of valve face.
3. Wash parts in solvent to remove lapping compound.
4. Check position of lap mark on face. Lap mark must be on or near center of valve face.
5. Apply a light coat of clean engine oil to seat and valve to prevent rusting.

Breather Inspection

Procedure:

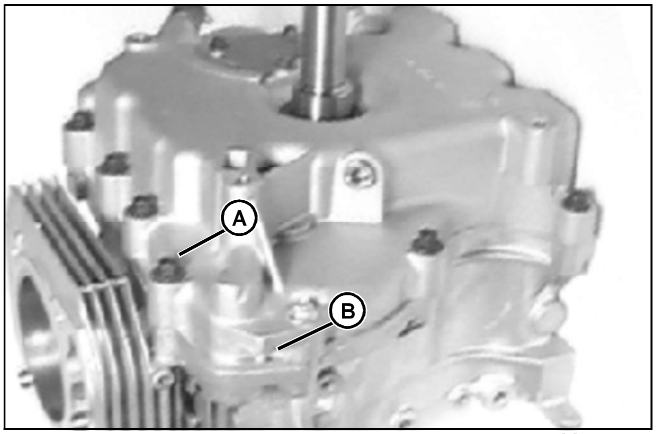


M55868

1. Remove cap screw (A), plate (B), and reed (C).
2. Check that breather opening is clear.
3. Replace reed if it does not lie flat on casting.
4. Clean mating surface of any sealant residue (D).

Oil Pan Removal and Installation

Procedure:

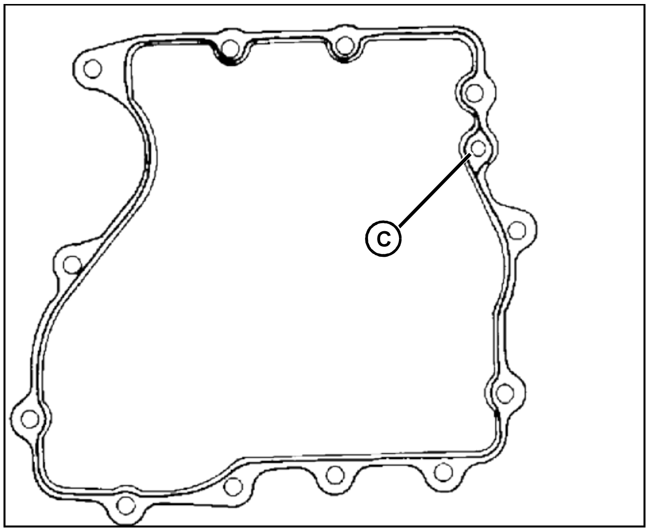


M55945

NOTE: Do not pry on gasket surface when removing oil pan from crankcase.

1. Remove cap screws (A).
2. Pry oil pan from crankcase using flat blade screwdriver on splitting tabs (B).
3. Clean mating surfaces of crankcase and oil pan.
4. Replace crankshaft seals. See “Oil Pan Seal Removal and Installation” on page 49, and “Crankcase Oil Seal Removal and Installation” on page 50.

IMPORTANT: Avoid damage! DO NOT get sealant in oil passage (C). Apply just enough to seal both sides of oil passage when case halves are fastened together.



M55901

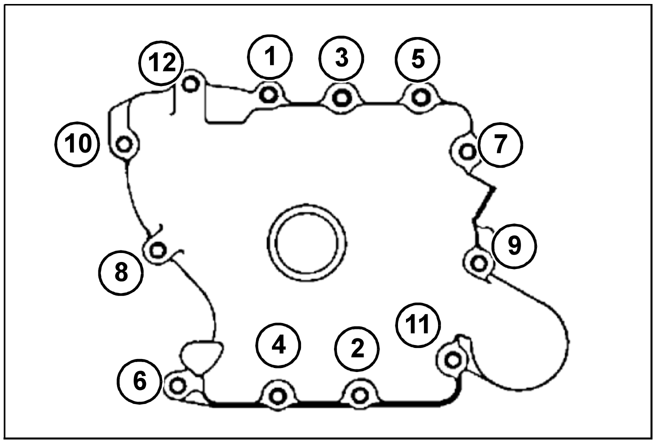
5. Apply 1.6 mm (1/16 in.) bead of TY1530 John Deere Form-in-Place Gasket to oil pan flange. DO NOT block oil passage (C).

6. Apply grease to inside lip of crankshaft main bearing seal.

7. Install oil pan over crankshaft carefully to avoid damaging main bearing seal.

IMPORTANT: Avoid damage! Be sure to align flats of balancer shaft and oil pump inner rotor when installing oil pan.

8. Install oil pan onto crankcase.

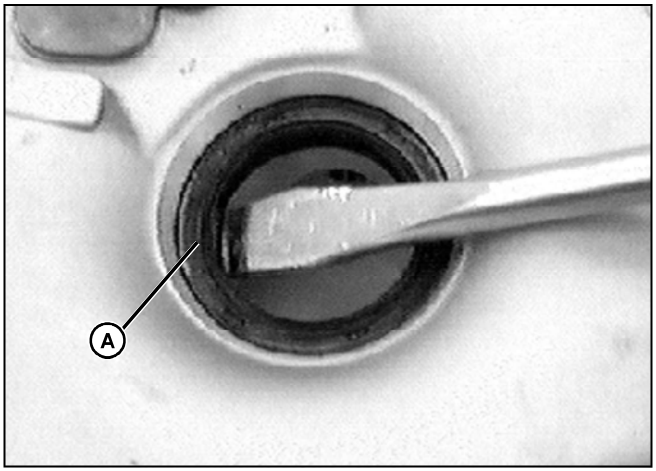


M52076

9. In sequence shown, tighten oil pan cap screws to 24 N•m (216 lb-in.).

Oil Pan Seal Removal and Installation

Procedure:

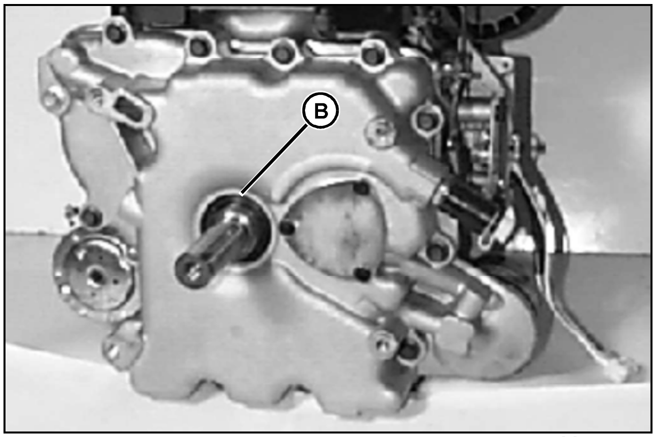


M55903

IMPORTANT: Avoid damage! DO NOT damage pan bore when removing seal.

1. Remove and discard seal (A).

2. When replacing crankshaft seals, apply a thin film of LOCTITE® 598 or equivalent to the OD of seal.



M94785

3. Using a suitable driver and disc (B), install new oil seal to specification.

Specification:

Oil Pan

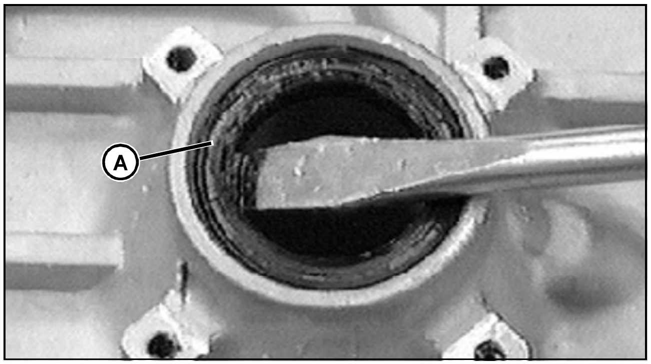
Seal Depth. . . . . 2.49 - 2.98 mm (0.098 - 0.117 in.) or until its top surface is flush with machined bore opening.

4. Apply grease to inside lip of seal to aid installation.

IMPORTANT: Avoid damage! Be sure to align flats of balancer shaft and oil pump inner rotor when installing oil pan. Prepare and install oil pan.

Crankcase Oil Seal Removal and Installation

Procedure:



IMPORTANT: Avoid damage! DO NOT damage crankcase bore when removing seal.

1. Remove and discard crankcase oil seal (A).
2. When replacing crankshaft seals, apply a thin film of LOCTITE® 598 or equivalent to the OD of seal.
3. Using a suitable driver and disc, install new oil seal to specification.

Specification:

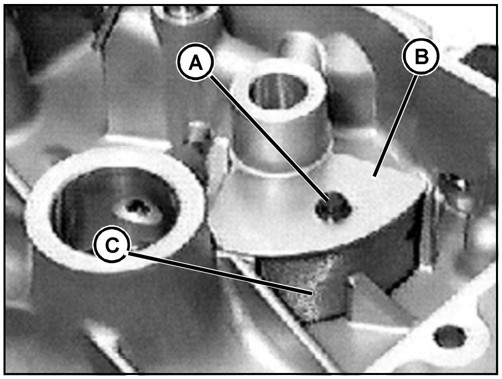
Crankcase Seal Depth
. . . . . 4.0 mm (0.157 in.) or until its top surface is flush with machined bore opening.

IMPORTANT: Avoid damage! Coat inside seal lip with grease to aid installation. Install crankshaft carefully to avoid damaging seal.

4. Carefully install crankshaft seal.

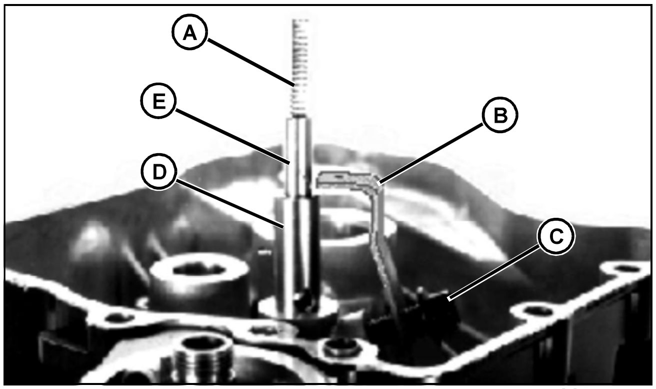
Oil Pickup Inspection

Procedure:



1. Remove cap screw (A) and plate (B) to remove pickup screen (C).
2. Clean screen with approved solvent. Replace if damaged.
3. Install screen, plate, and cap screw.
4. Install oil pan. See “Oil Pan Removal and Installation” on page 48.

Oil Pump Relief Valve Inspection



1. Loosen cap screw (C) and retainer (B) to gain access to individual components.
2. Remove and measure spring (A), replace if not to specification.

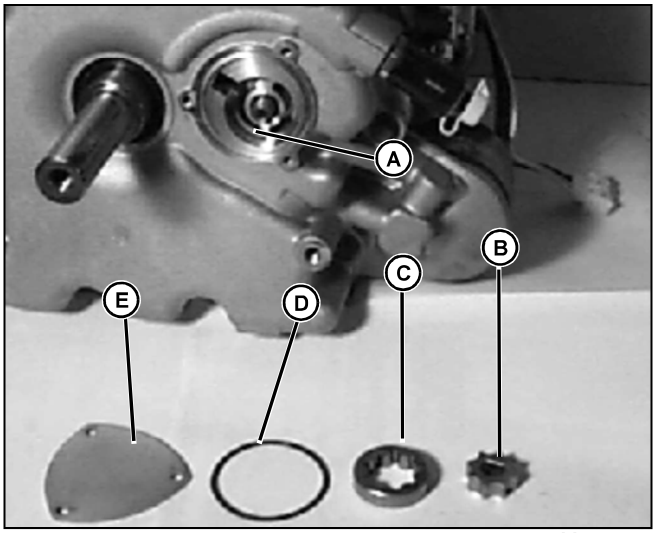
Specifications:

Relief Valve Spring Free Length . . . 25.19 mm (0.99 in.)

3. Inspect spring, piston (E), and body (D). Replace parts that are damaged or worn.
4. Install components with retainer and cap screw.
5. Install oil pan.

Oil Pump Installation

Procedure:



M94786

1. Remove cover (E), O-ring (D), pump outer rotor (C), and pump inner rotor (B).

2. Inspect rotor, pump, and inside surface of cavity (A) for scoring, discoloration, and wear.

3. Replace parts as necessary.

4. Lubricate parts (A, B, and C) with engine oil. Install in cavity.

5. Install O-ring and cover. Tighten cap screws to specification.

Oil Pump Cover Cap Screw Torque Specifications:

New Oil Pan (Thread Forming) . . . . 6.2 N•m (55 lb-in.)

Used Oil Pan (Threads Cut). . . . . 4.0 N•m (35 lb-in.)

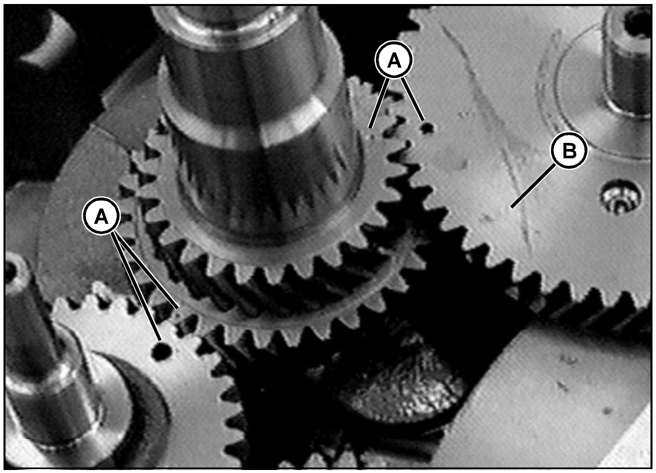
Oil Pump Cover-to-Rotor Clearance . . . . 0.076 mm (0.003 in.)

Camshaft Removal and Installation

Procedure:

1. Remove cylinder head. See "Cylinder Head Removal and Installation" on page 44.

2. Remove oil pan. See "Oil Pan Removal and Installation" on page 48.



M55873

3. Rotate crankshaft to align two sets of marks (A).

4. Remove camshaft (B).

5. Inspect camshaft closely, replace as necessary. See "Camshaft Inspection" on page 51.

6. Coat entire camshaft with engine oil.

7. Install camshaft with four timing marks (A) aligned.

8. Check camshaft end play.

9. If not within specification, use appropriate shims from Camshaft Shim Kit.

10. Align flat surface of balancer shaft with bore flat of oil pump inner rotor gear as you install oil pan.

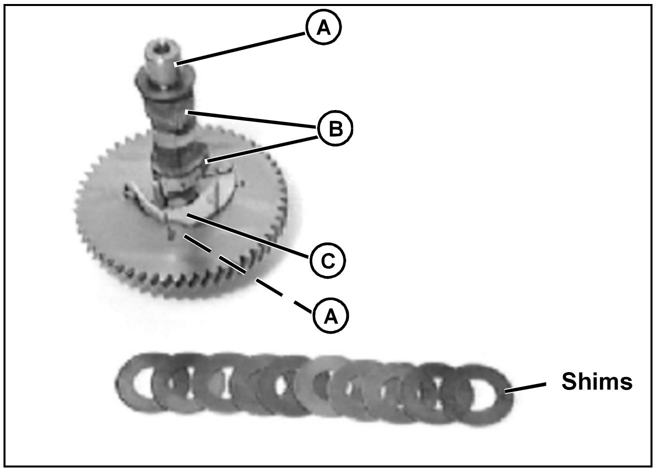
11. Install push rods, rocker arm assembly, and valve cover.

Specification:

Camshaft End Play. 0.076 - 0.127 mm (0.003 - 0.005 in.)

Camshaft Inspection

Procedure:



M58327

1. Inspect camshaft for worn or broken teeth.

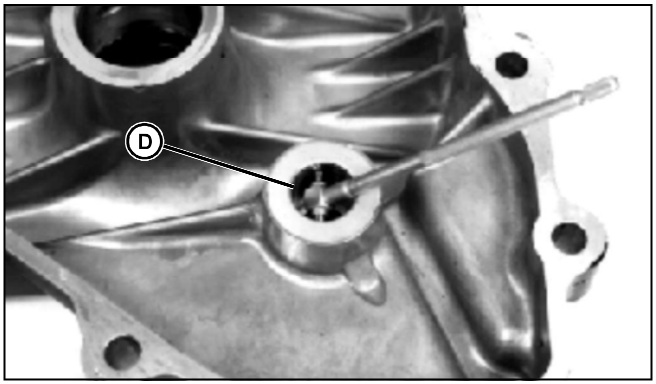
2. Measure camshaft journals (A) at both ends. Replace camshaft if measurements do not meet specifications.

Camshaft Journal OD
New . . . . 19.962 - 19.975 mm (0.7859 - 0.7864 in.)

Maximum Wear Limit . . . . 19.959 mm (0.7858 in.)

3. Inspect lobes (B). Replace camshaft if lobes show excessive wear.

4. Inspect ACR mechanism (C). Replace spring if necessary and check that weight moves freely.



M52091

5. Measure camshaft bore (D) in oil pan.

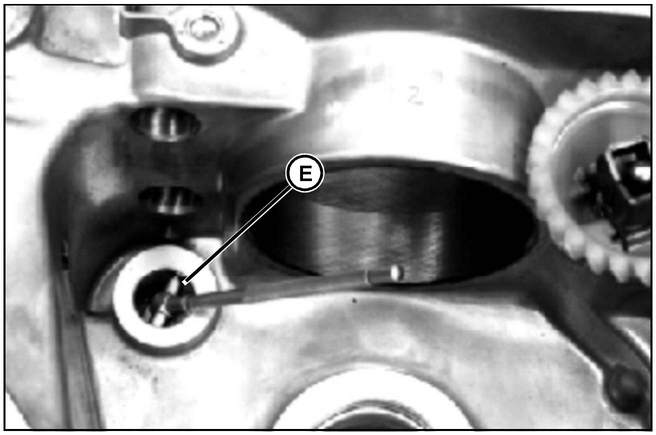
6. Subtract camshaft journal OD from bore ID to determine clearance with camshaft journal. Replace if not within specifications.

Specifications:

Oil Pan Camshaft Bore
New . . . . 20.000 - 20.025 mm (0.7874 - 0.7884 in.)

Maximum Wear Limit . . . . 20.038 mm (0.7889 in.)

Camshaft to Bore Clearance
. . . . 0.025 - 0.063 mm (0.0010 - 0.0025 in.)



M52092

7. Measure camshaft bore (E) in crankcase.

8. Subtract journal OD from bore ID to determine clearance with camshaft journal. Replace if not within specification.

Specifications:

Crankcase Camshaft Bore
(New) . . . . 20.000 - 20.025 mm (0.7874 - 0.7844 in.)

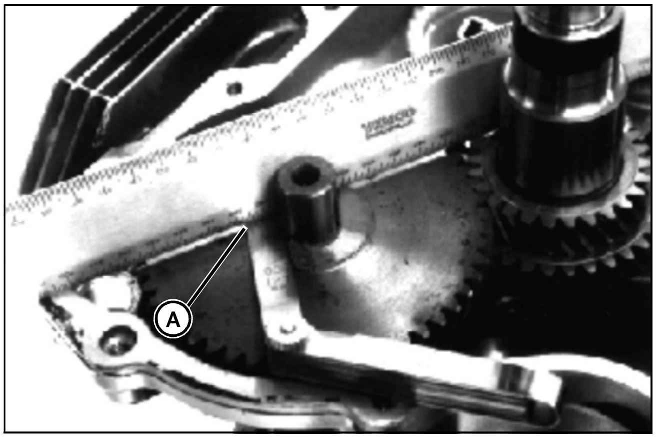
(Maximum Wear Limit). . . . . 20.038 mm (0.7889 in.)

Camshaft to Bore
Clearance . . . . . . 0.025 - 0.063 mm (0.0010 - 0.0025 in.)

Camshaft End Play Measurement

Procedure:

1. Check that camshaft is seated in crankcase bore.



M52093

2. Measure play (A) between camshaft and straight edge (spanning crankcase) using flat feeler gauge.

3. Use shims from Shim Kit as necessary until end play is within specification.

Specifications:

Camshaft End Play Specification:

Maximum
(with shims) . . . . . . 0.076 - 0.127 mm (0.003 - 0.005 in.)

Shim Thickness Range:

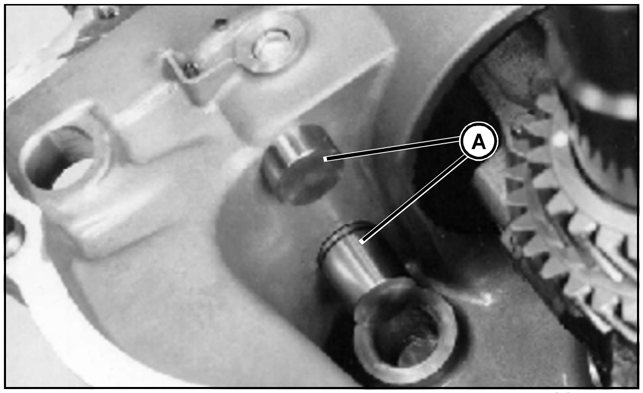
White . . . . 0.692 - 0.730 mm (0.0273 - 0.0288 in.)
Blue . . . . 0.743 - 0.781 mm (0.0293 - 0.0308 in.)
Red . . . . 0.794 - 0.832 mm (0.0313 - 0.0328 in.)
Yellow . . . . 0.845 - 0.883 mm (0.0333 - 0.0348 in.)
Green. . . . . 0.895 - 0.994 mm (0.0352 - 0.0368 in.)
Gray. . . . . 0.946 - 0.984 mm (0.0373 - 0.0388 in.)
Black . . . . 0.997 - 1.035 mm (0.0393 - 0.0408 in.)

Hydraulic Valve Lifters Removal and Installation

Procedure:

1. Remove camshaft.

IMPORTANT: Avoid damage! Used lifters are mated to their camshaft lobes. Mark them for installation in the correct bore.



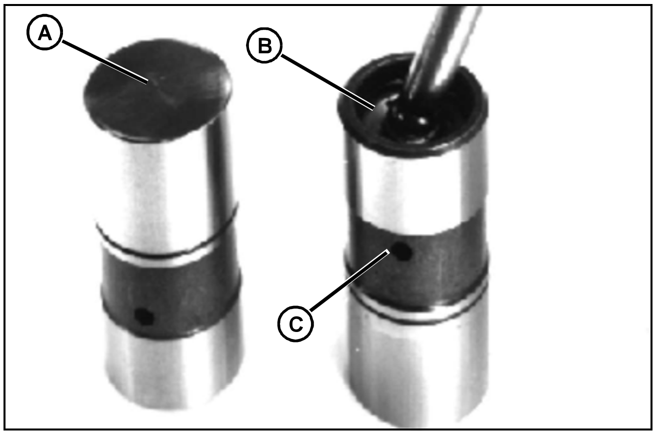
M85611

2. Remove lifters (A).
3. Inspect lifters for wear, replace as necessary.
4. Coat lifters with engine oil and install in correct bore.
5. Install camshaft.

Hydraulic Valve Lifters Inspection

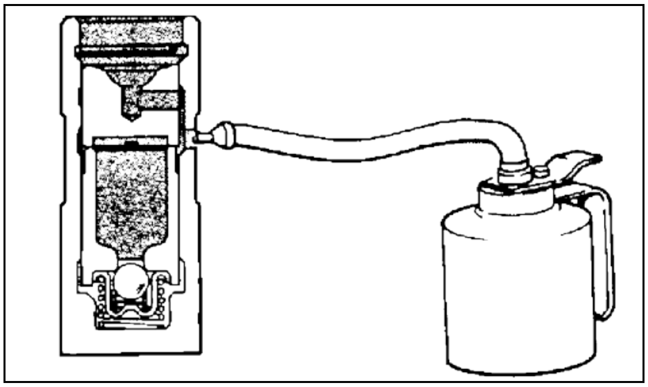
Procedure:

IMPORTANT: Avoid damage! Damaged or worn lifters usually indicate a damaged camshaft. Check camshaft before replacing lifters.



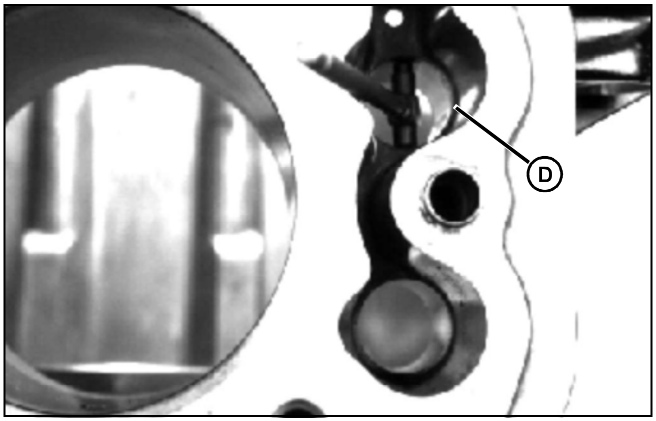
M52095

1. Inspect lifter face (A) for wear. Face should be flat and smooth.
2. Use push rod to depress plunger (B). Plunger should offer resistance but move smoothly.
3. Check that oil hole (C) is clear to inner piston.
4. Measure outside diameter of lifter.
5. Replace lifters that are worn or damaged.



M55899

NOTE: When installing new lifters, make sure lifters are full of oil. Submerge lifters in oil and use old push rod to pump lifter several times to purge air and fill with oil, or force oil into lifter with oil can (shown above), until lifter feels solid. Reassemble engine and allow 10 minutes for lifters to bleed down. Crank engine over by hand and check for compression. If no compression exists or engine cannot be turned, lifters have not bled down, and may have trapped air inside. Wait 10 minutes more to allow lifters to bleed down.



M52097

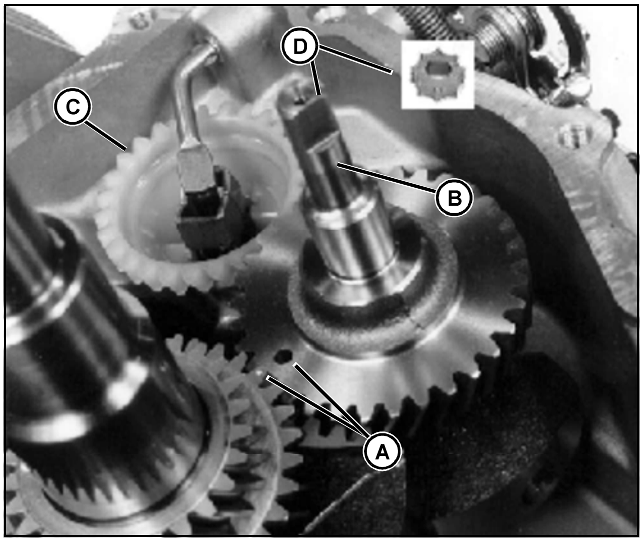
6. Measure inside diameter of crankcase lifter bore (D).
7. Subtract lifter OD from bore ID to determine if clearance is not within specification. Replace components as necessary.

Specification:

Valve Lifter To Bore Clearance (maximum) . . . 0.0124 - 0.0501 mm (0.0005 - 0.0020 in.)

Balancer Shaft Removal and Installation

Procedure:

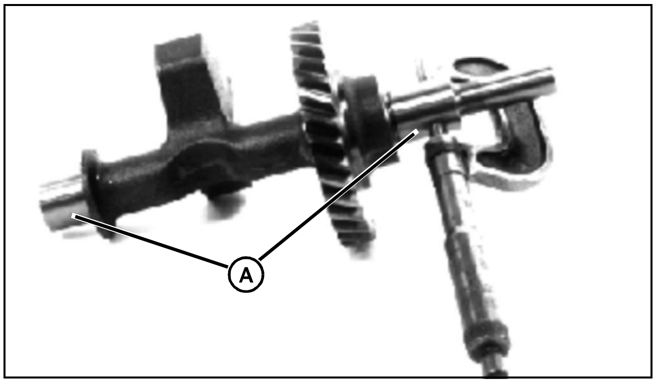


M85612

1. Align marks (A) on balancer shaft and crankshaft.
2. Remove balancer shaft (B).
3. Inspect balancer shaft, replace as necessary.
4. Align marks (A) and install balancer shaft (B) so it also aligns with governor gear (C).
5. When installing oil pan, be sure to align flat (D) of balancer shaft with bore flat of oil pump inner rotor gear.

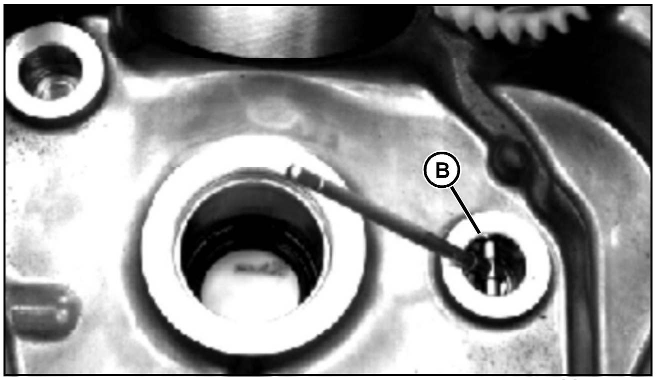
Balancer Shaft Inspection

Procedure:



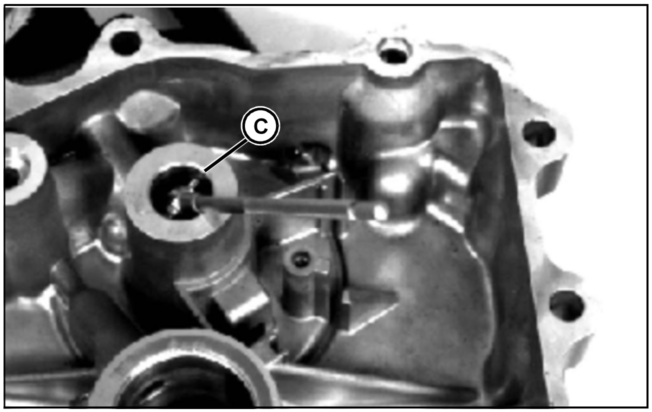
M52100

1. Inspect shaft for cracks and broken teeth. Replace shaft if cracked or damaged.
2. Measure journals (A). Replace if not within specification.



M52101

3. Measure balancer shaft bore (B) in crankcase.
4. Subtract journal OD from bore ID to determine clearance with balancer shaft journal. Replace crankcase if measurements are not within specifications.



M52102

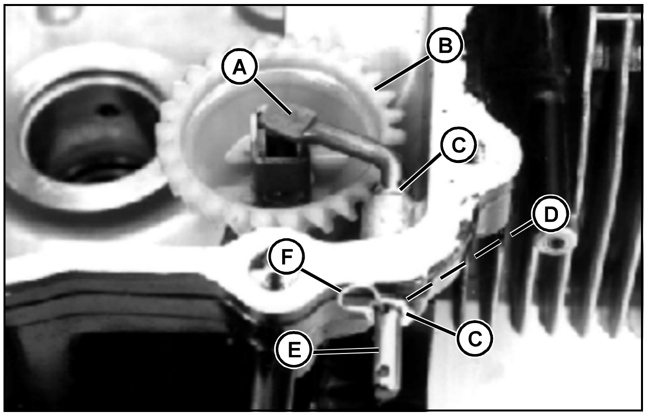
5. Measure balancer shaft bore (C) in oil pan.
6. Determine clearance with balancer shaft journal. Replace oil pan if measurements not within specifications.

Specifications:

Balancer Shaft Journal OD:
New . . . . 19.962 - 19.975 mm (0.7859 - 0.7864 in.)
Minimum . . . . 19.959 mm (0.7858 in.)
Balancer Shaft Crankcase Bore ID:
New . . . . 20.000 - 20.025 mm (0.7874 - 0.7884 in.)
Maximum. . . . . 20.038 mm (0.7889 in.)
Balancer Shaft to Crankcase Bore Clearance
. . . . 0.025 - 0.063 mm (0.0009 - 0.0025 in.)
Balancer Shaft Oil Pan Bore ID:
New . . . . 20.000 - 20.025 mm (0.7874 - 0.7884 in.)
Maximum. . . . . 20.038 mm (0.7889 in.)
Balancer Shaft to Crankcase Bore Clearance
. . . . 0.025 - 0.063 mm (0.0009 - 0.0025 in.)

Governor Removal and Installation

Procedure:



M52104

1. Remove governor lever (not shown) from end of control arm (E).

2. Remove spring clip (F), washers (C), and governor control arm (A) from inside of crankcase.

3. Remove and discard seal (D).

NOTE: Check governor shaft/gear assembly, if plastic gear, flyweight assembly, flyweight cap, and/or shaft are damaged, the complete assembly must be replaced.

4. Inspect governor shaft/gear assembly (B), replace as necessary.

5. Install governor shaft/gear assembly.

6. Install new seal (D) using suitable driver.

7. Install control arm, washers, and clip.

8. Install lever (not shown).

Governor Inspection

Procedure:

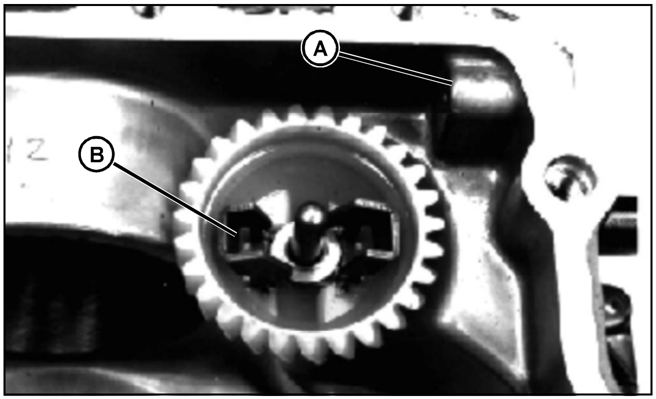
M52105

1. Measure outside diameter of control arm shaft. Replace if not within specification.

Governor Control Arm Specifications:

OD (New). . . . . . . 5.975 - 6.000 mm (0.2352 - 0.2362 in.)

Wear Limit (Minimum) . . . . 5.962 mm (0.2347 in.)



M52106

2. Measure inside diameter of crankcase bore (A). Replace block if inside diameter exceeds wear limit.

Governor Control Arm Crankcase Bore:

ID (New). . . . . 6.025 - 6.050 mm (0.2372 - 0.2382 in.)

Maximum. 6.063 mm (0.2387 in.)

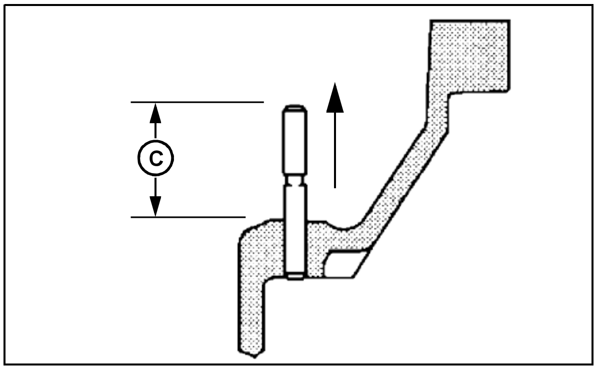
3. Determine governor control arm shaft-to-bore clearance. Replace governor shaft/gear assembly as necessary.

Governor Control Arm-to-Crankcase Bore:

Clearance . . . . . . 0.025 - 0.075 mm (0.0010 - 0.0030 in.)

4. Inspect flyweights (B) for proper operation and free movement. Replace governor shaft/gear assembly as necessary.

IMPORTANT: Avoid damage! DO NOT remove governor shaft with vise-grips or pliers, damage to case may result.



M42195

5. With a small punch, CAREFULLY drive governor shaft toward inside of crankcase to remove it.

6. From inside of crankcase, install new governor shaft/ gear assembly by pressing or lightly tapping shaft into crankcase bore to specified height (C).

Governor Gear Shaft Specifications:

Height (C) . . . . . . 32.639 - 32.842 mm (1.285 - 1.293 in.)

Diameter . . . . 5.990 - 6.000 mm (0.2358 - 0.2362 in.)

Diameter (Minimum). . . . . 5.977 mm (0.2353 in.)

Gear Shaft-to-Gear Bore Clearance . . . . . . 0.015 - 0.140 mm (0.0006 - 0.0055 in.)

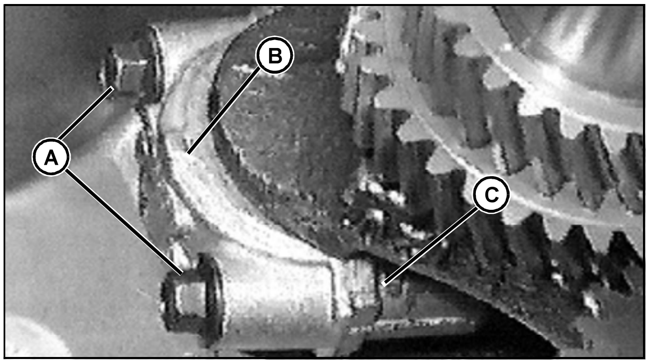
Piston Assembly Removal

Procedure:

1. Remove balance shaft, and camshaft.

IMPORTANT: Avoid damage! Remove carbon ridge, if present, from cylinder before removing piston.

2. Remove carbon ridge, if present at top of cylinder, using a ridge reamer.

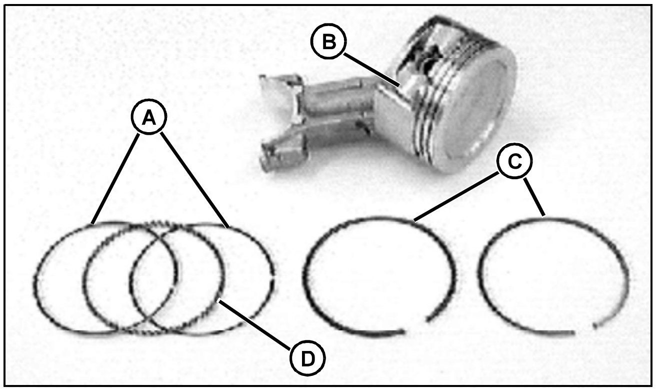


M55875

3. Remove cap screws (A) to remove cap (B) from connecting rod (C).
4. Remove piston assembly through top of cylinder.
5. Inspect piston assembly, see following two topics.

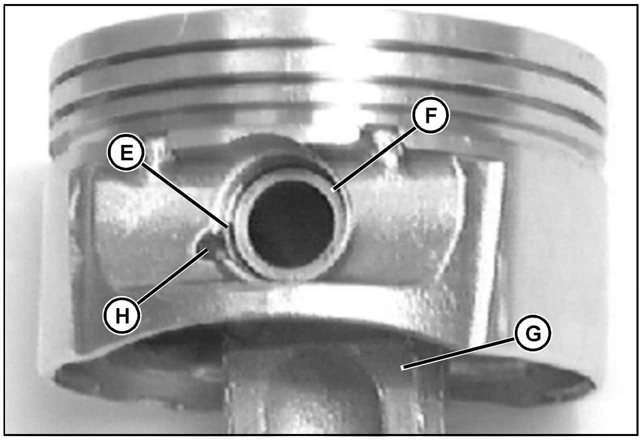
Piston Assembly Disassemble

Procedure:



M55894

1. Remove compression rings (C) from piston (B) using ring expander.
2. Remove rails (A).
3. Remove spacer (D).



M55878

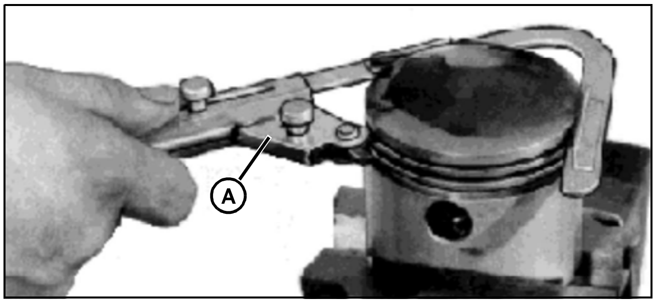
4. Remove retaining rings (E) by prying at indent (H).
5. Use wooden dowel to remove pin (F) from piston and connecting rod (G).
6. Inspect parts.

Piston Inspection

Procedure:

1. Carefully remove piston rings.

IMPORTANT: Avoid damage! Do not use caustic cleaners or wire brush to clean aluminum piston. Piston damage can result



M29946

2. Clean piston. Inspect for scoring or fractures.

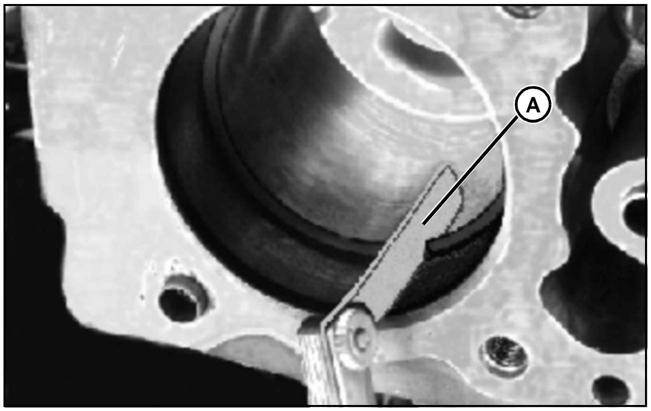
3. Clean carbon from grooves using ring groove tool (A).

Piston Ring End Gap Measurement

Procedure:

IMPORTANT: Avoid damage! If new rings are to be installed, deglaze cylinder so rings will seat properly.

1. Use a clean or new piston to push piston compression ring squarely into bore, to a point where it normally runs.



M52110

2. Measure end gap (A).

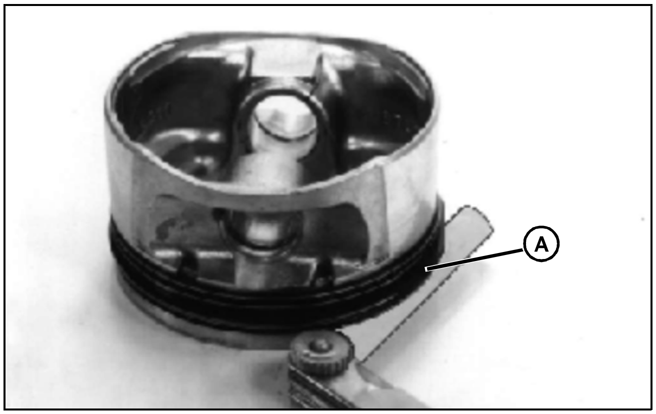
3. Remove ring and file ends squarely until gap meets specification. Rings with too large a gap must be replaced. If one piston ring needs replaced, all must be replaced as a set.

Specifications:

Piston Ring End Gap
(New Bore). . . . . 0.27 - 0.51 mm (0.010 - 0.020 in.)
Piston Ring End Gap (Used Bore)
Maximum . . . . 0.77 mm (0.030 in.)

Piston Ring Side Clearance Measurement

Procedure:



M52111

1. Measure piston ring side clearance (A) as shown at several points around piston.

2. Replace piston if measurements exceed clearance specifications.

Specifications:

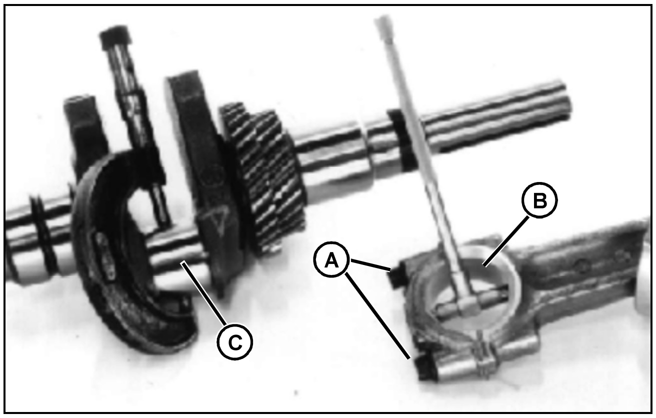
Piston Ring-To-Groove Side Clearance

Top Compression
Ring . . . . 0.060 - 0.105 mm (0.0023 - 0.0041 in.)
Middle Compression
Ring . . . . 0.040 - 0.085 mm (0.0015 - 0.0033 in.)
Oil
Control Ring . . . . 0.176 - 0.026 mm (0.0069 - 0.0010 in.)

Piston Assembly Measurement

Procedure:

NOTE: Connecting rod is available 0.25 mm (0.010 in.) undersize.

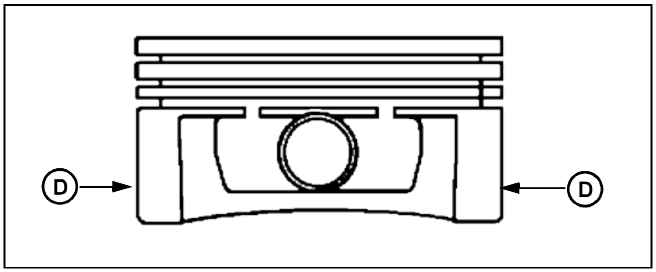


M52112

1. Tighten cap screws (A) to specification.

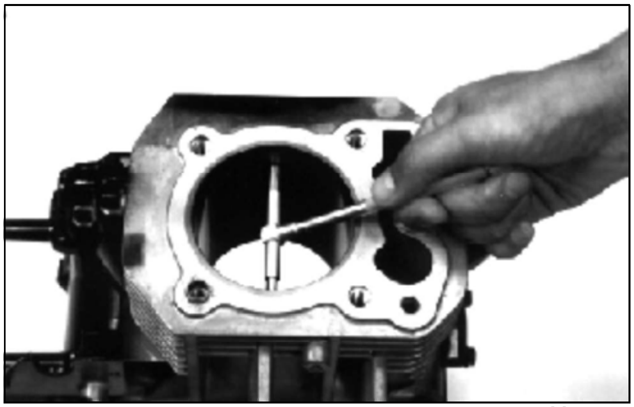
2. Measure inside diameter of connecting rod (B).
3. Measure outside diameter of crankshaft journal (C).
4. Determine connecting rod-to-crankshaft clearance.

Replace parts that are not within specifications.



M52148

5. Measure diameter of piston at a point (D), 6 mm (0.25 in.) from skirt bottom and perpendicular to piston pin.



M52125

6. Measure cylinder bore.
7. Replace piston and/or rebore cylinder block if not within specifications.

Crankshaft Specifications:

Connecting Rod Journal OD:

New . . . . 38.958 - 38.970 mm (1.5338 - 1.5343 in.)
Wear Limit . . . . 38.94 mm (1.5328 in.)
Taper (maximum) . . . . 0.012 mm (0.0005 in.)
Out-Of-Round (maximum) . . . . . . 0.025 mm (0.0010 in.)

Crankshaft-to-Connecting Rod Clearance:

New . . . . 0.030 - 0.055 mm (0.0012 - 0.0022 in.)
Maximum . . . . 0.07 mm (0.0025 in.)

Connecting Rod Specifications:

Piston Pin End ID:

New . . . . 19.015 - 19.023 mm (0.7486 - 0.7489 in.)
Maximum . . . . 19.036 mm (0.7495 in.)

Piston Pin OD:

New . . . . 18.995 - 19.000 mm (0.7478 - 0.7480 in.)
Minimum . . . . 18.994 mm (0.7478 in.)

Cap Screw Torque:

8 mm Straight Shank . . . . 22.7 N•m (200 lb-in.)
Step Down Shank . . . . 14.7 N•m (130 lb-in.)
6 mm Straight Shank . . . . 11.3 N•m (100 lb-in.)

Piston Specifications:

Piston Thrust Face OD:

New . . . . 89.951 - 89.969 mm (3.5413 - 3.5420 in.)
Minimum . . . . 89.824 mm (3.5363 in.)

Thrust Face to Cylinder Bore Clearance . . 0.031 - 0.043 mm (0.0012 - 0.0016 in.)

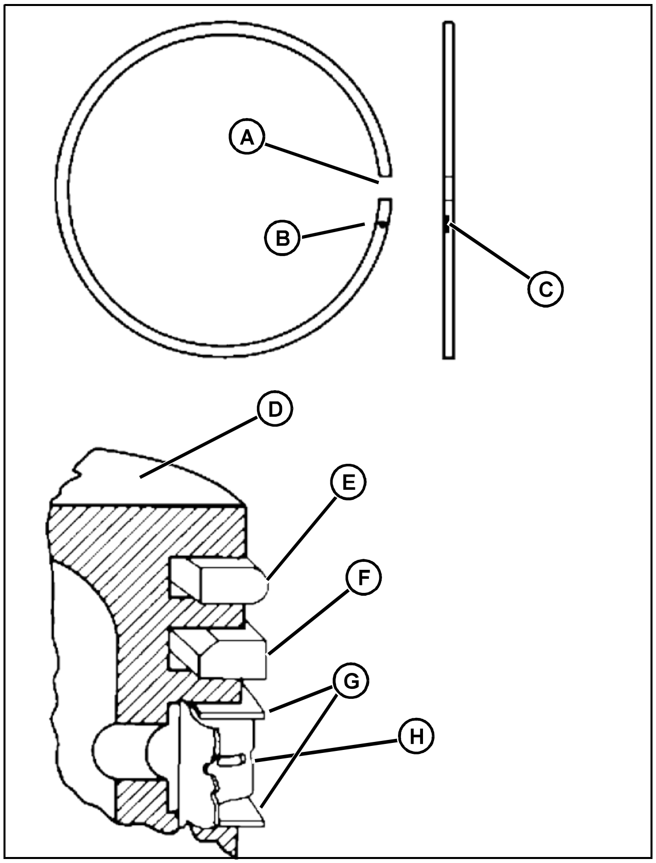
Piston Pin Bore ID:

New . . . . 19.006 - 19.012 mm (0.7483 - 0.7485 in.)
Maximum. . . . . 19.025 mm (0.7490 in.)

Piston Assembly

Procedure:

IMPORTANT: Avoid damage! Side of ring marked TOP faces top of piston with Dykem stripe to left of end gap. Top compression ring has a blue Dykem stripe. Bottom compression ring has a pink Dykem stripe.



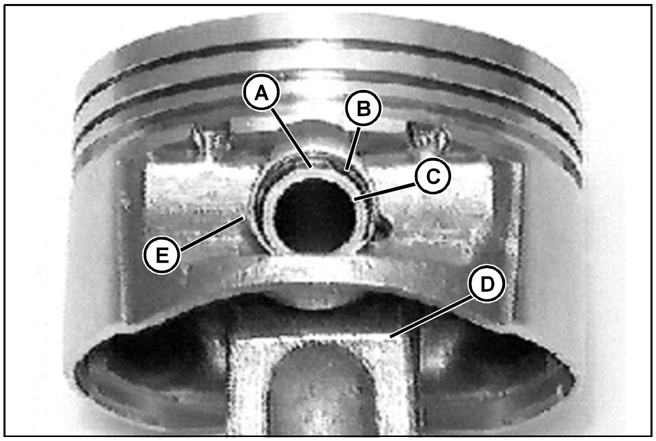
M55898

A - "Pip" Mark
B - Ring Gap
C - Dykem Stripe
D - Piston
E - Top Compression Ring
F - Center Compression Ring
G - Oil Rails
H - Oil Spacer

1. Install rings as shown on piston using ring expander.
   - Compression ring gaps should be staggered 120°
   - Note shape of compression rings and install as shown
   - Compression rings should be installed with "Pip" mark up and Dykem strip to left of ring gap
   - Install oil ring spacer first. Make sure that its ends do not overlap
   - Stagger end gaps of oil rails 180° apart
   - Rings should turn freely in grooves

IMPORTANT: Avoid damage! Retaining rings (B) should be installed with end gap (A) pointing up.

NOTE: Install piston pin before retaining ring to prevent possible scoring of bore.



M55879

2. Install one piston pin retaining ring (B) in groove of piston bore (E).

3. Install pin (C) through piston bore (E) and connecting rod (D). Pin should install easily with thumb pressure.

4. Install remaining retaining ring (B) in opposite side.

Piston Installation

Special or Required Tools:

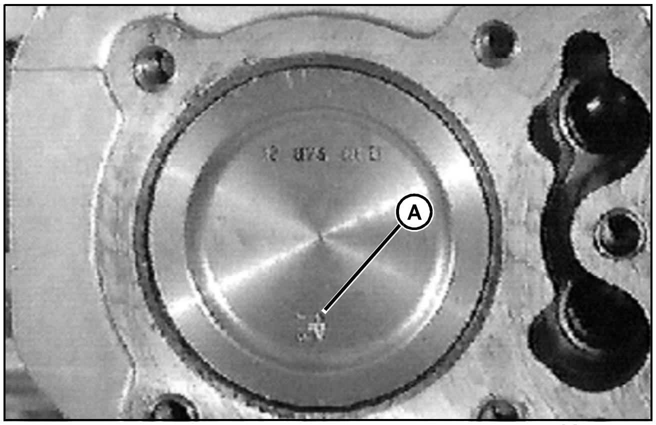
- Piston Ring Compressing Tool

Procedure:

1. Install piston rings so piston ring end gaps are staggered 120° apart.

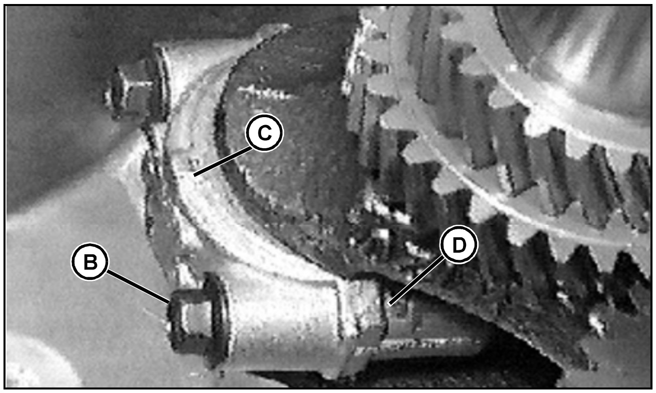
2. Coat cylinder, piston skirt, rod, and cap bearing surfaces with oil.

3. Compress rings with ring compressor tool.



M55871

4. Install piston with FLY mark (A) toward flywheel side of crankcase. Use wooden dowel to push piston into bore.



M55875

5. Fasten connecting rod (D) and cap (C) to crankshaft.
6. Tighten cap screws (B) to specification.
7. Check connecting rod to crankshaft side clearance. Replace if not within specification.
8. Install balance shaft, camshaft, oil pan, and cylinder head. See appropriate procedures in this section.

Connecting Rod Specifications:

Cap Screw Torque:

8 mm Straight Shank . . . . 22.7 N•m (200 lb-in.)

Step Down Shank . . . . 14.7 N•m (130 lb-in.)

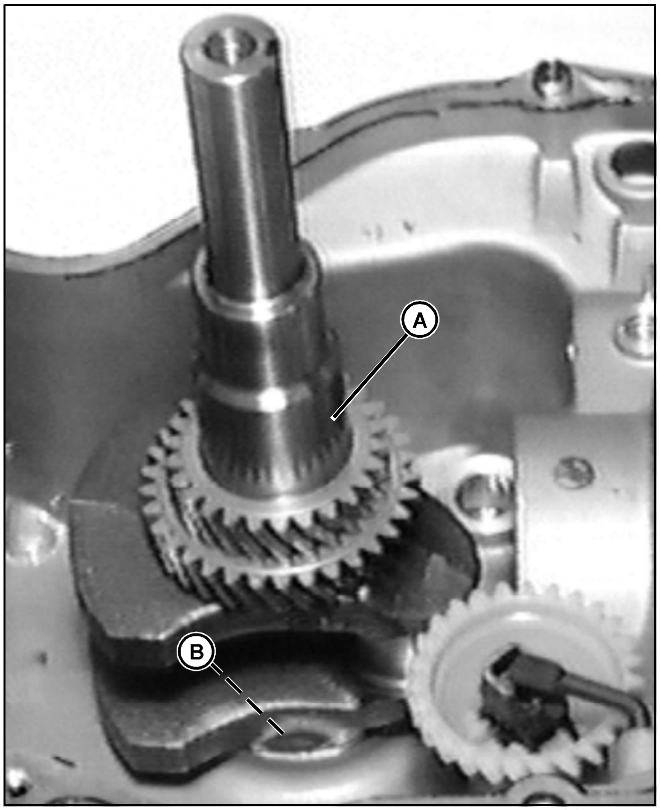
6 mm Straight Shank . . . . 11.3 N•m (100 lb-in.)

Side Clearance . . . . . . 0.18 - 0.41 mm (0.007 - 0.016 in.)

Crankshaft Removal and Installation

Procedure:

1. Remove camshaft and balancer assemblies.



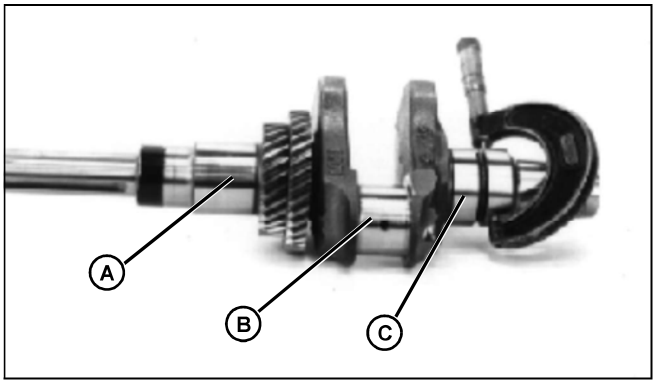
M58334

2. Remove and inspect crankshaft (A).
3. Install new seals (B) in crankcase and oil pan.
4. Install crankshaft carefully; DO NOT damage seals.

Crankshaft and Main Bearing Inspection

Procedure:

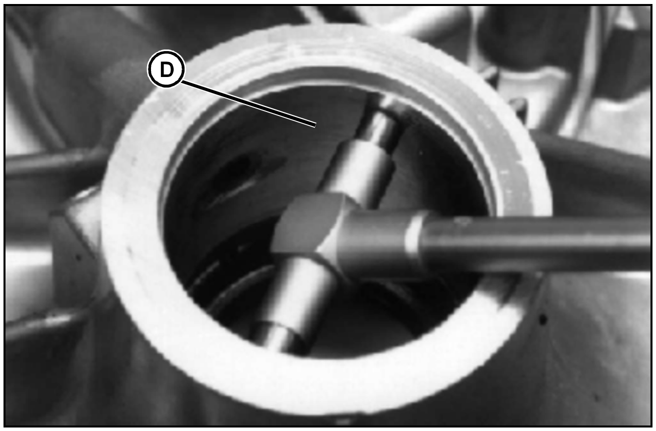
1. Inspect for cracks or chipped teeth.



M52114

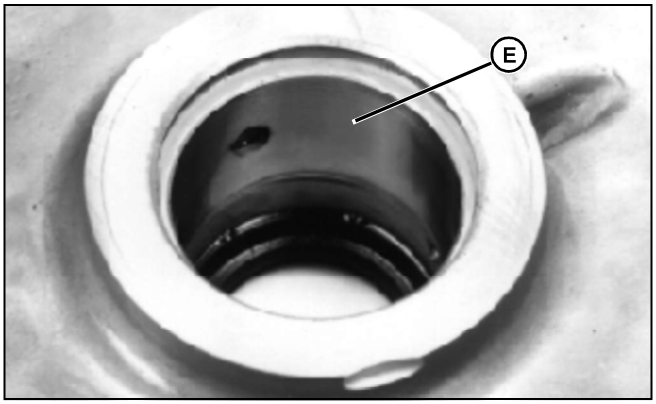
2. Check crankshaft alignment, see next heading.
3. Measure journals (A), (B), and (C).

Replace crankshaft if bent, damaged, or not within specifications.



M52115

4. Measure inside diameter of crankshaft main bearing bore (D) in oil pan.



M52116

5. Measure inside diameter of crankshaft main bearing bore (E) in crankcase.

6. Subtract journal OD from bore ID to determine if clearance is within specifications. Replace parts if not within specifications.

Crankshaft Journal Specifications:

Oil Pan End Main Journal OD:

New . . . . 41.915 - 41.935 mm (1.6502 - 1.6510 in.)
Minimum . . . . 41.86 mm (1.648 in.)
Taper (maximum) . . . . 0.020 mm (0.0008 in.)
Out-of-Round (maximum) . . . . . . 0.025 mm (0.0010 in.)

Flywheel End Main Journal OD:

New . . . . 44.913 - 44.935 mm (1.7682 - 1.7691 in.)
Minimum . . . . 44.84 mm (1.765 in.)
Taper (maximum) . . . . 0.022 mm (0.0009 in.)
Out-of-Round (maximum) . . . . . . 0.025 mm (0.0010 in.)

Connecting Rod Journal OD:

New . . . . 38.958 - 38.970 mm (1.5338 - 1.5343 in.)
Minimum . . . . 38.94 mm (1.5328 in.)
Taper (maximum) . . . . 0.012 mm (0.0005 in.)
Out-of-Round (maximum) . . . . . . 0.025 mm (0.0010 in.)

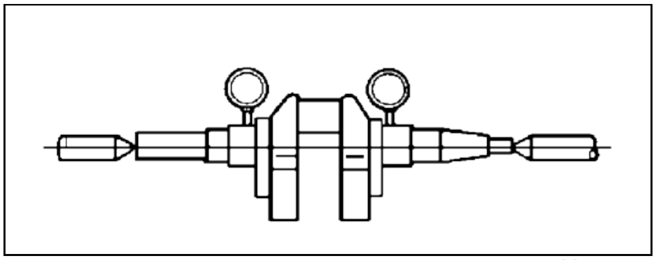
Crankshaft Sleeve Bearing Bore Specifications:

Oil Pan & Crankcase Main Bearing Bore ID . . . . . . 44.965 - 45.003 mm (1.7703 - 1.7718 in.)
Main Bearing Bore-to-Crankshaft Clearance . . . . 0.03 - 0.09 mm (0.0012 - 0.0035 in.)

Crankshaft Alignment

Procedure:

In alignment jig:



M80432

- Rotate crankshaft slowly. Dial indicators (A) measure maximum Total Indicated Runout (TIR).

In engine:

- Rotate crankshaft slowly. Measure TIR at oil pan end of crankshaft using dial indicator.

Replace crankshaft if not within specification.

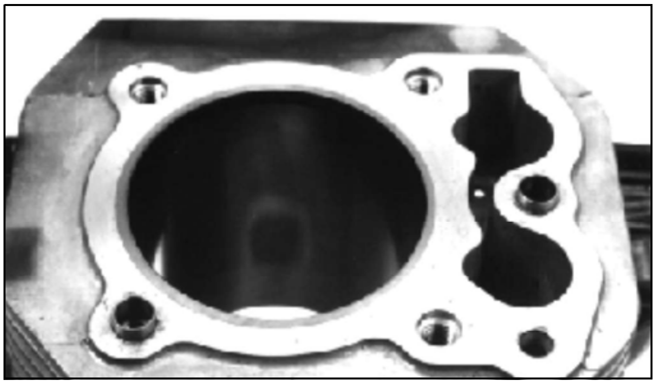
Specifications:

Crankshaft Maximum TIR:

In Alignment Jig . . . . 0.10 mm (0.0039 in.)
In Engine . . . . 0.15 mm (0.0059 in.)

Cylinder Block Removal and Installation

Procedure:



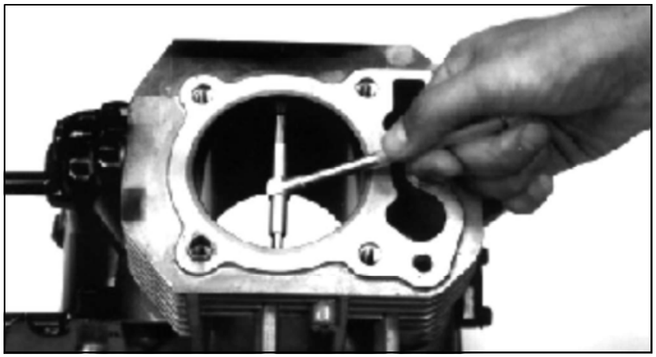
M52133

All components must be removed from block before inspection or machine work can be performed.

Cylinder Block Inspection

Procedure:

1. Clean and check block for cracks.
2. Cracks not visible to the eye may be detected by coating the suspected area with mixture of 25 percent kerosene and 75 percent light engine oil.
3. Wipe area dry and immediately apply coating of zinc oxide dissolved in wood alcohol. If crack is present, coating becomes discolored at the defective area.
4. Replace block if any cracks are found.



M52125

5. Measure cylinder bore inside diameter at six places; two measurements 90° apart at top, middle, and bottom of ring travel.
6. Measure piston outside diameter perpendicular to piston pin bore.

NOTE: Pistons and rings are available 0.25 and 0.50 mm (0.010 and 0.020 in.) oversize.

Replace block or bore cylinder to accept larger piston if clearance exceeds specification.

Specifications:

Cylinder Bore:

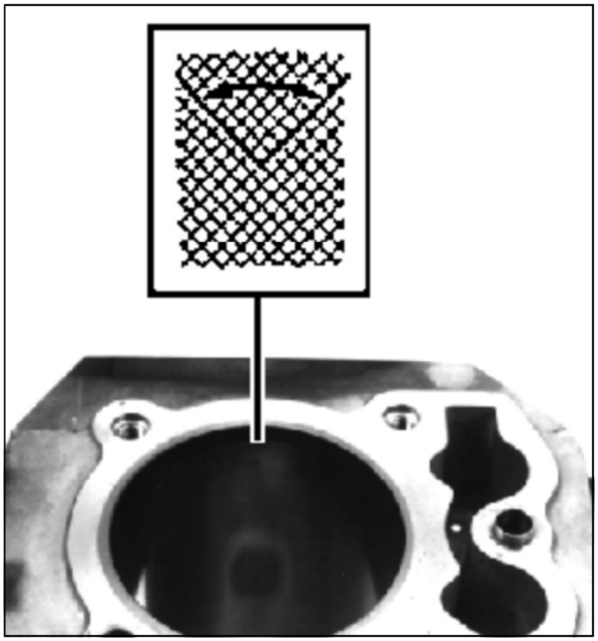
New . . . . 90.000 - 90.025 mm (3.5433 - 3.5443 in.)
Maximum. . . . . 90.063 mm (3.5681 in.)

Out-of-Round (maximum) . . . . 0.12 mm (0.0047 in.)
Taper (maximum) . . . . 0.05 mm (0.0020 in.)
Piston-to-Cylinder Clearance . . . . . . 0.031 - 0.043 mm (0.0012 - 0.0016 in.)

Cylinder Bore Deglazing

IMPORTANT: Avoid damage! Remove crankshaft and internal engine components when deglazing cylinder. Abrasives can cause engine damage.

1. Use the appropriate size flex-hone to deglaze cylinder bore.



M58336

2. Deglaze cylinder bore using flex-hone to obtain 23 - 33° crosshatch pattern.
3. Clean abrasive residue from cylinder using warm soapy water until clean white rags show no discoloration.
4. Dry cylinder and apply engine oil.

Specification:

Deglaze Crosshatch Pattern . . . . 23 - 33°

Starting Motor

Removal and Installation:

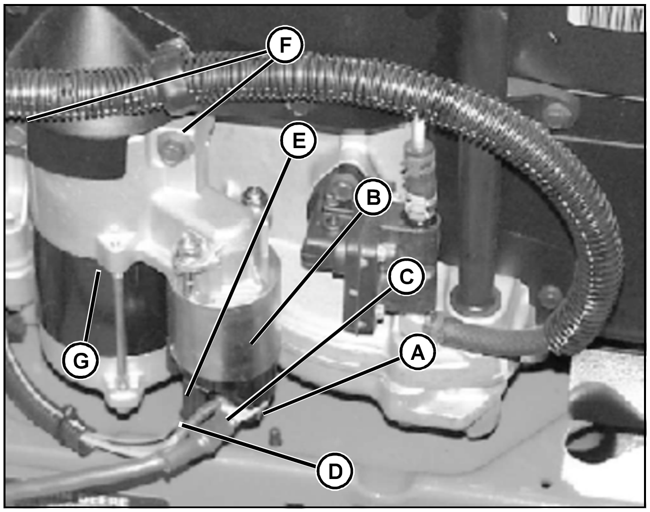
⚠ CAUTION: Avoid Injury! ROTATING BLADES/ MOVING PARTS. STOP engine. Remove ignition key. Wait for all moving parts to STOP.

1. Park machine on a hard, level surface. Engage parking brake.
2. Open the hood.

NOTE: Disconnect negative (-) battery cable first.

3. Disconnect negative (-) battery cable at the battery.

4. Disconnect positive (+) cable from starting motor.



M99571

5. Remove nut and lock washer (A) from bottom of start motor solenoid (B).

6. Disconnect positive (+) battery cable (C) and charging wire (D) from solenoid.

7. Disconnect key switch connector (E) from solenoid.

8. Remove two cap screws (F) and starter (G).

Installation is done in the reverse order of removal.

NOTE: Connect negative (-) battery cable last.

- Tighten cap screws to 24 N•m (216 lb-in.).
- Clean all battery cable connections before installing cable.

Analyze Condition:

The starter overheats because of:

- Long cranking.
- Armature binding.

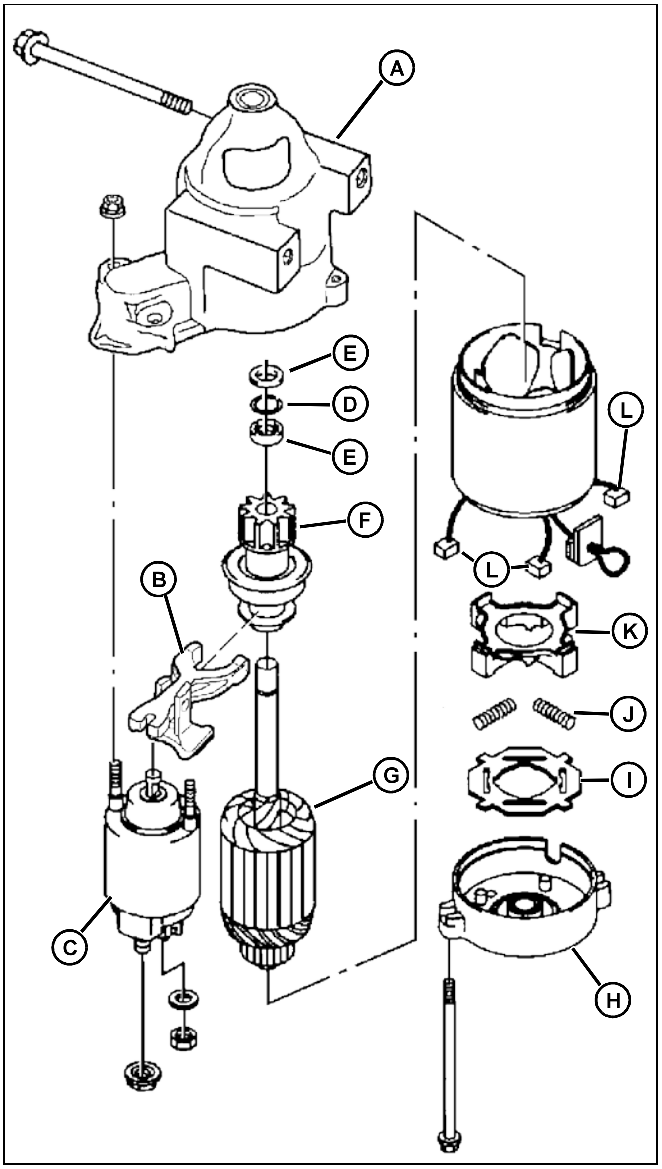
The starter operates poorly because of:

- Armature binding.
- Dirty or damaged starter drive.
- Badly worn brushes or weak brush springs.
- Excessive voltage drop in cranking system.
- Battery or wiring defective.
- Shorts, opens, or grounds in armature.

NOTE: Starter repair is limited to brushes, end caps, and starter drive. Fields in starter are permanent magnets and are not serviceable. If housing or armature is damaged, replace starter.

Disassembly and Assembly:

1. Mark body and covers for correct alignment during reassembly.



MX9622

A - Front Cover
B - Shift Lever
C - Solenoid
D - Retaining Clip
E - Pinion Stopper
F - Pinion
G - Armature
H - End Cover
I - Insulator
J - Brush Springs
K - Brush Holder
L - Brush

2. Push pinion stopper (E) toward pinion (F) to remove retaining clip (D).

3. Inspect parts for wear or damage.

4. Test solenoid (C), starter armature (G) and brushes (O). (See "Inspection/Test" procedures below.)

Assembly is done in the reverse order of disassembly.

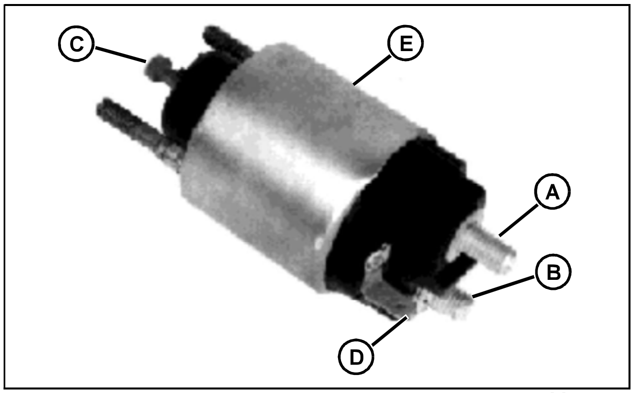
Apply a thin coat of multipurpose grease to:

- Sliding surfaces of armature and solenoid shift lever.
- Armature shaft spline.
- Points where shaft contacts cover.

Inspection and Test:

1. Measure field coil brush lengths. If any one brush length is less than 10.5 mm (0.413 in.), replace all four brushes.

2. Inspect brush springs for wear or damage. Replace if necessary.



M51705

3. Test solenoid terminals (A and B) for continuity. There should be no continuity.

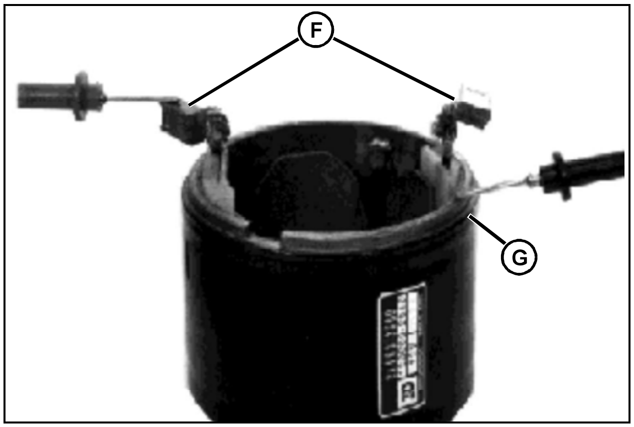
4. Depress switch arm (C). There should be continuity when arm is fully depressed.

5. Test for open circuits between terminal (B) and tang (D). There should be continuity.

6. Test for open circuits between tang (D) and body (E). There should be continuity.

7. If solenoid fails any test, it is defective and must be replaced.

8. Test for grounded field winding. Touch one probe of tester to field coil brush and the other probe to the field coil housing. Be sure the brush lead is not touching the frame. If there is continuity, the coil is grounded and the field coil housing must be replaced.

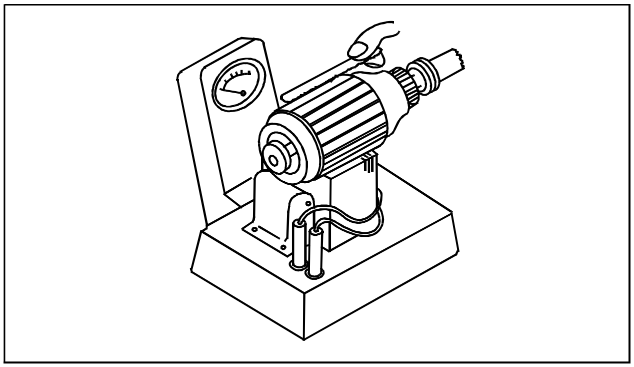


M50115

9. Test for open field coil. Touch one probe of tester to each field coil brush (F). If there is no continuity, the field coil is open and the field coil housing assembly (G) must be replaced.

IMPORTANT: Avoid damage! Do not clean armature with solvent. Solvent can damage insulation on windings. Use only mineral spirits and a brush.

M50116



MIF

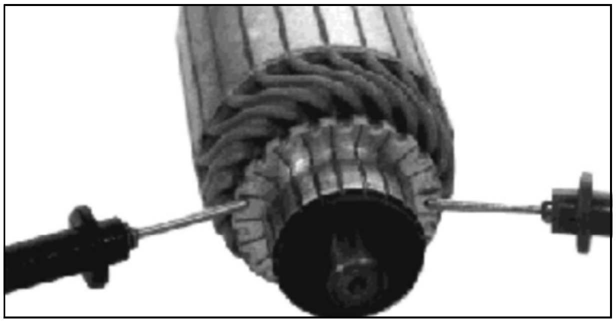
10.Locate short circuits by rotating armature on a growler while holding a hacksaw blade or steel strip on armature. The hacksaw blade will vibrate in area of short circuit.

NOTE: Shorts between bars are sometimes caused by dirt or copper between bars. Inspect for this condition.

11.If test indicates short circuited windings, clean the commutator of dust and fillings. Check armature again. If test still indicates short circuit, replace armature.

M50112

12.Test for grounded windings using an ohmmeter. Touch probes on each commutator bar. Armature windings are connected in parallel, so each commutator bar needs to be checked. If test shows continuity, a winding is grounded and the armature must be replaced.



M50113

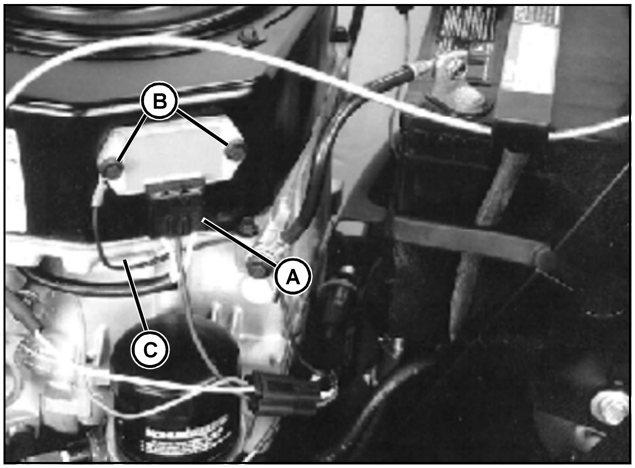
13.Test for open circuited windings using an ohmmeter. Touch probes on each commutator bar. If test shows no continuity, there is an open circuit and armature must be replaced.

Voltage Regulator/Rectifier

Removal and Installation:

IMPORTANT: Avoid damage! Disconnect battery negative (-) cable (if engine is still in machine) to prevent damage to voltage regulator/rectifier.

1. Disconnect battery negative (-) cable.



M83666

2. Disconnect wiring harness connector (A).
3. Remove cap screws (B) and ground wire (C).
4. Remove voltage regulator/rectifier.

Installation is done in the reverse order of removal.

- Tighten cap screws to 7.3 N•m (65 lb-in.).

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ENGINE - KAWASAKI (AIR-COOLED) SPECIFICATIONS

Specifications

General Specifications

Make	**Kawasaki V-Twin**
Type	**Gasoline**
Model Number (LX277)	**FH500V-BS11**
Model Number (LX288 - SN 090001-)	**FH580V-AS04**
Horsepower (LX277 - FH500V)	**12.7 kW (17 hp)**
Horsepower (LX288 - FH580V, SN 090001-)	**13.4 kW (18 hp)**
Bore (LX288, SN 090001-) FH580V	**74 mm (2.91 in.)**
Bore (LX277) FH500V	**68 mm (2.68 in.)**
Stroke	**68 mm (2.68 in.)**
Displacement (LX288 - FH580V, SN 090001-)	**585 cm3 (35.7 cu in.)**
Displacement (LX277 - FH500V)	**494 cm^2 (30.0 cu in.)**
Cylinders	**2 (V-twin)**
Stroke/Cycle	**4 Cycle**
Compression Ratio	**8.5:1**
Compression Release	**Automatic Compression Release**
Valves	**Overhead**
Lubrication	**Pressurized**
Oil Filter	**Single Element, Full Flow, Spin-On Filter**
Engine Oil Capacity	
With Filter	**1.7 L (1.8 US qt)**
Without Filter	**1.5 L (1.6 US qt)**
Cooling System	**Air Cooled**
Air Cleaner	**Dry Replaceable with Foam Pre-cleaner**
Governor Flyweight	**All Speed Governor**
Muffler	**Horizontal Discharge Below Frame**
Carburetor	**Float Type, Fixed Main Jet**
Ignition System	**Transistorized Fly Wheel Magneto**
Battery Reserve Capacity @ 25 amp	**90 Minutes**
Battery CCA @ -18° C (0° F)	**500 amp**

Test and Adjustment Specifications

Slow Idle (LX277 - FH500V)	**1550 ± 75 rpm**
Slow Idle (LX288 - FH580V, 090001-) (Governed)	**1700 rpm**
Fast Idle (LX277 - FH500V)	**3350 ± 50 rpm**
Fast Idle (LX288 - FH580V, SN 090001-)	**3400 rpm**
Ignition Coil Air Gap	**0.30 mm (0.012 in.)**
Ignition Timing @3000 rpm	**20° BTDC**
Resistance Between Primary Lead and Core	**9k**
Spark Plug Type	**Champion RCJ8Y**
Spark Plug Gap (LX277 - FH500V)	**1.00 mm (0.040 in.)**
Spark Plug Gap (LX288 - FH580V)	**0.75 mm (0.030 in.)**
Spark Plug Torque (LX277 - FH500V)	**15 N•m (130 lb-in.)**
Spark Plug Torque	**22 N•m (195 lb-in.)**
Cap Screw Torque	**7.8 N•m (69 lb-in.)**

Oil Pressure at Fast Idle	**241 - 310 kPa (35 - 45 psi)**
Oil Pressure Switch (open to close)	**98 kPa (14.2 psi)**
Minimum Cylinder Compression Pressure	**390 kPa (57 psi)**
Maximum Difference Between Cylinders	**41 kPa (6 psi)**
Fuel Pump Minimum Pressure (at slow idle)	**2.45 kPa (0.36 psi)**
Fuel Pump Minimum Flow (at slow idle)	**800 mL/60 seconds (0.8 qt/60 seconds)**
Fuel Pump Push Rod Bend (Maximum)	**0.05 mm (0.002 in.)**
Valve Clearance (Cold) (LX277- FH500V)	**0.05 - 0.10 mm (0.002 - 0.004 in.)**
Valve Clearance (Cold) (LX288 - FH580V, SN 090001-)	**0.10 - 0.15 mm (0.004 - 0.006 in.)**
Valve Adjustment Screw Jam Nut Torque	**6.9 N•m (61 lb-in.)**
Rocker Arm Cover Cap Screw Torque	**6.9 N•m (61 lb-in.)**
Minimum Crankcase Vacuum	**1.27 - 25.4 cm (0.5 - 10.0 in.) water**

Starting Motor:

Amperage (No Load) (Maximum)	**50 amps at 5000 rpm**
Brush Length (Minimum)	**6.4 mm (0.250 in.)**
Wire Connection to Solenoid Nut Torque	**9.8 N•m (84 lb-in.)**
Mounting Bolts	**15 N•m (132 lb-in.)**

Repair Specifications

Cylinder Head:

Cylinder Head Flatness (Maximum Warp)	**0.05 mm (0.002 in.)**
Valve Guide ID (Maximum)	**6.08 mm (0.239 in.)**
Valve Seat Width	**0.6 - 0.9 mm (0.024 - 0.35 in.)**

Valve Spring Free Length (Minimum)

LX277 - FH500V	**26.7 mm (1.05 in.)**
LX288 - FH580V (SN 090001-)	**31.0 mm (1.22 in.)**

Valves and Valve Lifters:

Valve Clearance (Intake and Exhaust - LX277 - FH500V) (Cold)	**0.05 - 0.10 mm (0.002 - 0.004 in.)**
Valve Clearance (Intake and Exhaust - LX288 - FH580V, SN 090001-)	**0.10 - 0.15 mm (0.004 - 0.006 in.)**
Push Rod Bend (Maximum)	**0.5 mm (0.020 in.)**
Valve Stem OD - Intake (Minimum)	**5.95 mm (0.234 in.)**
Valve Stem OD - Exhaust (Minimum)	**5.93 mm (0.233 in.)**
Valve Stem Bend (Maximum)	**0.03 mm (0.001 in.)**
Valve Guide ID	**6.08 mm (0.239 in.)**
Valve Margin (Minimum)	**0.35 mm (0.014 in.)**
Valve Seating Surface Width Intake	**0.6 - 0.9 mm (0.024 - 0.035 in.)**
Valve Seating Surface Width Exhaust	**1.1 - 1.6 mm (0.04 - 0.06 in.)**
Valve Spring Free Length (Minimum)	**31.0 mm (1.220 in.)**
Valve Seat and Face Angle	**45°**
Valve Narrowing Angle	**30°**

Cylinder Bore, Pistons and Rings:

Ring Groove Side Clearance (Maximum):

Top Ring	**0.15 mm (0.006 in.)**
Second Ring	**0.12 mm (0.006 in.)**

Oil Ring	0.20 mm (0.008 in.)
Piston Pin OD (Minimum)	15.96 mm (0.628 in.)
Piston Pin Bore OD (Maximum)	16.08 mm (0.633 in.)
Piston Pin Bearing ID (Maximum)	16.05 mm (0.633 in.)
Cylinder Bore Out of Round:	
Standard	0.056 mm (0.0004 in.)
Wear Limit	0.01 mm (0.0022 in.)
Piston Rings:	
Ring Thickness (Top and Second Ring) (Minimum)	1.40 mm (0.055 in.)
Ring End Gap (Maximum):	
Compression Rings (Top)	0.70 mm (0.028 in.)
Compression Ring (Second)	0.78 mm (0.031 in.)
Oil Ring End Gap (Maximum)	1.05 mm (0.041 in.)
Oil Ring End Gap (Minimum)	0.18 mm (0.007 in.)

Piston OD LX277 (FH500V)

Standard Piston (Minimum)	67.79 mm (2.669 in.)
Oversize Piston - 0.50 mm (0.020 in.)	68.29 mm (2.689 in.)
Piston to Cylinder Bore Clearance	0.015 - 0.150 mm (0.0006 - 0.0059 in.)

Piston OD LX288 (SN 090001-) (FH580V)

Standard Piston (Minimum)	73.79 mm (2.905 in.)
Oversize Piston	0.50 mm (0.020 in.) 75.49 mm (2.970 in.)
Piston to Cylinder Bore Clearance	0.015 - 0.150 mm (0.0006 - 0.0059 in.)

Cylinder Bore ID LX277 (FH500V)

Standard	67.98 - 68.00 mm (2.76 - 2.677 in.)
Wear Limit (Maximum)	68.10 mm (2.681 in.)

Oversize Bore 0.50 mm (0.020 in.) LX277 (FH500V)

Standard	68.48 - 68.50 mm (2.696 - 2.697 in.)
Wear Limit (Maximum)	68.60 mm (2.701 in.)

Cylinder Bore ID LX288 (SN 090001-) (FH580V)

Standard	73.98 - 74.00 mm (2.912 - 2.913 in.)
Wear Limit (Maximum)	74.10 mm (2.917 in.)

Oversize Bore 0.50 mm (0.020 in.) LX288 (SN 090001-) (FH580V)

Standard	74.48 - 74.50 mm (2.932 - 2.933 in.)
Wear Limit (Maximum)	74.60 mm (2.937 in.)

Connecting Rod:

Connecting Rod Piston Pin ID (Maximum)	16.05 mm (0.632 in.)
Connecting Rod Bearing ID - LX277 (FH500V)	35.055 mm (1.380 in.)
Connecting Rod Bearing ID - LX288 - FH580V (SN 090001-) (Maximum)	38.055 mm (1.498 in.)
Connecting Rod Big End Width (Minimum)	18.80 mm (0.74 in.)

Crankshaft:

Crankshaft Crankpin Width (Maximum)	39.50 mm (1.56 in.)
Crankshaft Crankpin OD LX277 (FH500V) (Minimum)	34.94 mm (1.376 in.)

Crankshaft Crankpin OD LX288 (FH580V) (SN 090001-)(Minimum)	**37.94 mm (1.494 in.)**
Crankshaft Main Bearing PTO Journal OD (Minimum)	**34.90 mm (1.374 in.)**
Crankshaft Main Bearing Flywheel Journal OD (Minimum)	**34.93 mm (1.375 in.)**
Crankshaft Runout (TI R) (Maximum)	**0.05 mm (0.002 in.)**
Crankshaft Crankpin OD (Resized)	**37.457 - 37.470 mm (1.4747 - 1.4752 in.)**
Crankcase Cover Plain Bearing ID (Maximum)	**35.15 mm (1.384 in.)**

Camshaft:

End Journal OD (Minimum)	**15.985 mm (0.629 in.)**
Lobe Height (Minimum)	**29.131 mm (1.1469 in.)**
Bearing ID (Minimum)	**16.136 mm (0.635 in.)**

Oil Pump:

Rotor Shaft OD (Minimum)	**10.923 mm (0.430 in.)**
Rotor Shaft Bearing ID (Maximum)	**11.072 mm (0.436 in.)**
Outer Rotor Thickness (Minimum)	**9.830 mm (0.387 in.)**
Outer Rotor OD (Minimum)	**40.47 mm (1.593 in.)**
Inner and Outer Rotor Clearance (Maximum)	**0.2 mm (0.008 in.)**
Rotor Bearing Depth (Maximum)	**10.23 mm (0.430 in.)**
Rotor Bearing ID (Maximum)	**40.80 mm (1.606 in.)**
Relief Valve Spring Free Length (Minimum)	**19.50 mm (0.775 in.)**
Pump Housing Depth (Maximum)	**10.23 mm (0.403 in.)**
Oil Pressure Sensor Continuity (On)	**98 kPa (14.2 psi)**
Oil Filter Bypass Valve Opening Pressure	**78.5 - 117.5 kPa (11.4 - 17.1 psi)**

Governor:

Governor Mounting Shaft Height	**32.2 - 32.8 mm (1.267 - 1.291 in.)**

Starting Motor:

Maximum Amperage (No Load)	**50 amps at 6000 rpm**
Brush Length (Minimum)	**6.4 mm (0.25 in.)**

Torque Specifications

NOTE: Use appropriate torque wrench which will read within the inch pound range given, or convert inch pounds to foot pounds as follows: Inch-pounds/12 = Foot-pounds

Fuel System:

Choke Valve Screw	**0.7 N•m (6 lb-in.)**
Throttle Valve Screws (FH500V)	**1.0 N•m (9 lb-in.)**
Throttle Valve Screws (FH580V)	**0.7 N•m (6 lb-in.)**
Pilot Jet	**1.7 N•m (15 lb-in.)**
Main Jet (FH500V)	**0.7 N•m (6 lb-in.)**
Main Jet (FH580V)	**2.3 N•m (20 lb-in.)**
Main Air Jet	**0.7 N•m (6 lb-in.)**
Main Nozzle	**2.0 N•m (17 lb-in.)**
Pilot Air Jet	**0.7 N•m (6 lb-in.)**
Drain Screw (Carburetor)	**1.3 N•m (11 lb-in.)**

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Earth Lead Screw (Carburetor Side)	**3.4 N•m (30 lb-in.)**
Fuel Shutoff Solenoid Valve (Carburetor)	**6.9 N•m) (61 lb-in.)**
Float Chamber Mounting Screw (LX277 - FH500V)	**8.8 N•m (78 lb-in.)**
Float Chamber Mounting Screw (LX288 - FH580V)	**8.8 N•m (40 lb-in.)**
Governor Shaft Plate Screws	**2.0 N•m (18 lb-in.)**
Holder Plate Nuts (Air Cleaner, Carburetor Mounting)	**5.9 N•m (52 lb-in.)**
Air Cleaner Body Mounting Screws	**3.4 N•m (30 lb-in.)**

Cooling System:

Engine to Shroud Bolt (M8)	**15 N•m (11 lb-ft)**
Engine to Shroud Bolts (M6)	**5.9 N•m (52 lb-in.)**
Plug Bolt (Engine to Shroud)	**5.9 N•m (52 lb-in.)**
Plug Screw (Engine to Shroud)	**3.4 N•m (30 lb-in.)**

Breather Cover Cap Screws	**6.9 N•m (61 lb-in.)**
Carburetor Mounting Stud Nut	**6.9 N•m (61 lb-in.)**
Connecting Rod Cap Screw	**5.9 N•m (52 lb-in.)**
Cooling System Cap Screws	**6.9 N•m (61 lb-in.)**
Engine Mounting Cap Screws	**34 N•m (25 lb-ft)**
Exhaust Pipe Nuts	**6.9 N•m (61 lb-in.)**
Fan Housing Cap Screws	**6.9 N•m (61 lb-in.)**
Fuel Pump Mounting Cap Screw Torque	**16 N•m (142 lb-in.)**
Fuel Solenoid	**6.9 N•m (61 lb-in.)**
Ignition Coil Cap Screws	**7.8 N•m (69 lb-in.)**
Oil Pressure Switch	**9.8 N•m (87 lb-in.)**
Oil Pump Cover Plate Cap Screws	**6.9 N•m (61 lb-in.)**
Rocker Arm Cap Screw	**27 N•m (240 lb-in.)**
Rocker Cover Cap Screws	**6.9 N•m (61 lb-in.)**
Spark Plug Torque LX277 - FH500V	**15 N•m (133 lb-in.)**
Spark Plug Torque LX288 - FH580V (SN 090001-)	**22 N•m (195 lb-in.)**
Starting Motor Cap Screws	**17 N•m (150 lb-in.)**
Stator Coil Cap Screws	**3.9 N•m (35 lb-in.)**
Engine Mounting Cap Screw Torque	**26 N•m (230 lb-in.)**
Flywheel Bolt Torque	**56 N•m (41 lb-ft)**
Cylinder Head and Valves Cap Screw Torque in Sequence (Lubricated)	
Final Torque	**25 N•m (221 lb-in.)**
Crankcase Cover Cap Screw Torque	**25 N•m (221 lb-in.)**
Oil Drain Plug Torque	**20 N•m (171 lb-in.)**
Connecting Rod End Cap Screw Torque	**9.8 N•m (87 lb-in.)**
Governor Arm Clamp Nuts	**7.8 N•m (69 lb-in.)**
Governor Lever Nut Torque	**7.8 N•m (69 lb-in.)**
Intake Manifold Mounting Cap Screws	**5.9 N•m (52 lb-in.)**

Electrical:

Starter Coil Screws	**3.4 N•m (30 lb-in.)**
Flywheel Bolt	**56 N•m (41 lb-ft)**
Fan Housing Bolts	**5.9 (52 lb-in.)**

Screen Bolts	**5.9 N•m (52 lb-in.)**
Regulator Screws	**3.4 N•m (30 lb-in.)**
Ignition Coil Bolts (Studs)	**7.8 N•m (69 lb-in.)**
Ignition Coil Bolts (Bolts)	**5.9 N•m (52 lb-in.)**
Starter Motor Mounting Bolts	**15 N•m (11 lb-ft)**

Tools and Materials

Tools

NOTE: Order tools according to information given in the U.S. SERVICE-GARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

Special or Required Tools

Tool Name	Tool No.	Tool Use
Hand-Held Digital Tachometer	JT05719	Used to check idle speed and starter performance.
Digital Pulse Tachometer	JT07270	Used to check idle speed and starter performance.
Compression Gauge	JDM59	Used to check engine compression.
U-Tube Manometer Test Kit	JT05698	Used to check engine crankcase vacuum.
Vacuum Gauge	JT03503	Used to check engine crankcase vacuum.
Drill Bit	6.4 mm (0.25 in.)	Throttle and choke adjustment.
Reaming Tool (7.05 m)	D20020WI	Used to clean or size valve guides.
Reaming Tool (7.25 mm)	JDG705	Used to bore oversize valve guide.
Lapping Tool	- - -	Valve lapping
Dial Indicator	- - -	Automatic compression relief test, valve inspection, crankshaft end play.
Spark Plug Ground	JDM74A5	Used to prevent accidental engine starting during tests.
90° Elbow Fitting	JT03338	Used to connect pressure gauge to engine when performing Engine Oil Pressure Test.
Connector	JT03349	Used to connect pressure gauge to engine when performing Engine Oil Pressure Test.
Hose Assembly	JT03017	Used to connect pressure gauge to engine when performing Engine Oil Pressure Test.
Pressure Gauge Assembly	JT03344	Used to read engine oil pressure when performing Engine Oil Pressure Test.
Pressure Gauge	JDG356	Used to check fuel pump performance.
Spark Tester	D-05351ST	Used to check overall condition of ignition system.
Valve Spring Compressor	JDM70	Used to remove and install valve springs.
Current Gun	JT05712	Used to check starter performance.
Cylinder Leak Tester	JT035029	Cylinder Leak Test

Special or Required Tools

Tool Name	Tool No.	Tool Use
Oil Pressure Test Adapter w/ O-ring (required ONLY on engines without test ports)	JT07262	Oil Pressure Test
Connector	JT05487	Oil Pressure Test
Hose Assembly	JT03017	Oil Pressure Test
Coupler	JT03262	Oil Pressure Test
Gauge 0 - 700 kPa (0 - 100 psi)	JT07034	Oil Pressure Test

Other Materials

Other Material

Part No.	Part Name	Part Use
M79292	MPG-2® Multipurpose Grease	Apply to engine crankshaft
	SCOTCH-BRITE® Abrasive Sheets/Pads	Clean cylinder head
	Valve Guide Cleaner	Clean valve guides
	Prussian Blue Compound	Check valve seat contact
	Lithium Base Grease	Pack oil seals
	Zinc Oxide/Wood Alcohol	Check block for cracks
	Mineral Spirits	Clean armature
	Valve Lap Compound	Lap valves
T43512 / TY9473 / LOCTITE,242	Thread Lock and Sealer (Medium Strength)	Apply to threads of throttle and choke plate screws
TY15130 / LOCTITE,395	Form-in-Place Gasket	Rocker arm cover mating surfaces
TY9375/TY9480/ LOCTITE,592	Thread Sealant (General Purpose) with TEFLON,	Apply to threads of oil pressure switch

MPG-2, is a registered trademark of DuBois USA.

LOCTITE, is a registered trademark of the Loctite Corp.

SCOTCH-BRITE, is a registered trademark of the 3M Co.

TEFLON® is a registered trademark of DuPont

Service Parts Kits

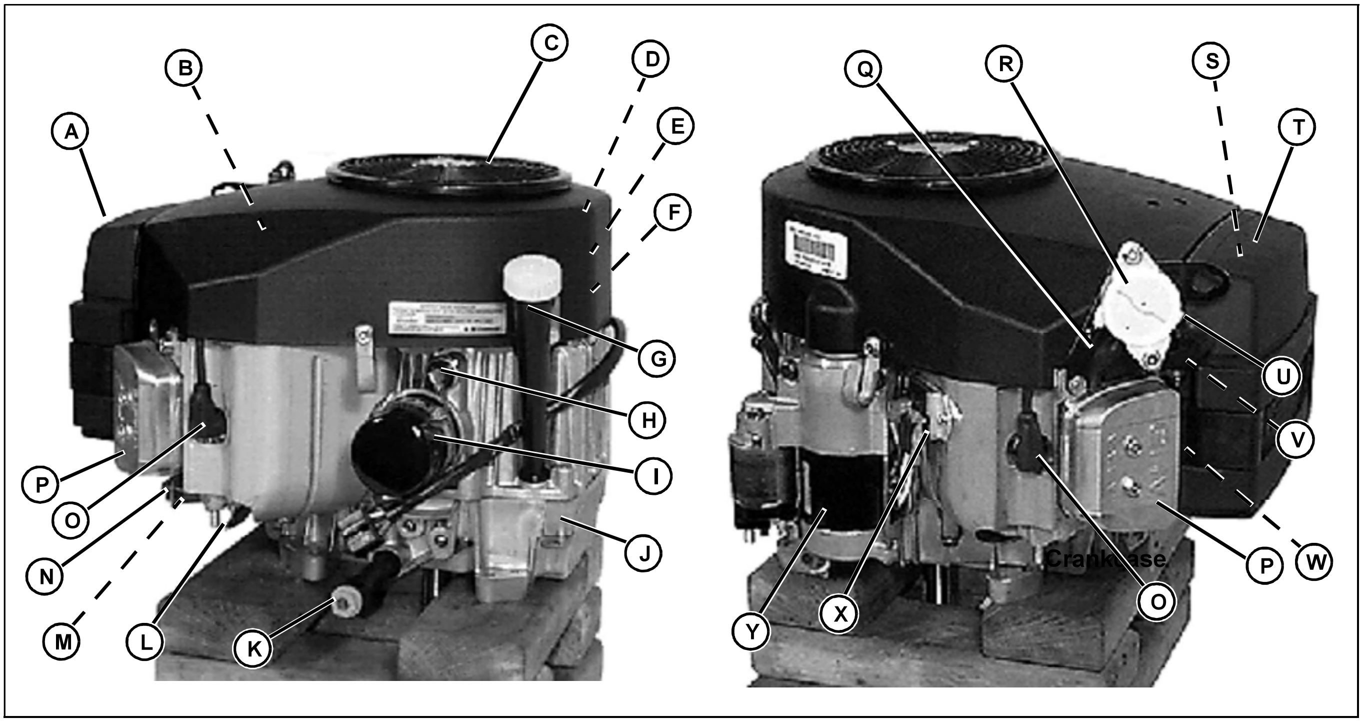
The following kits are available through your parts catalog:

- Carburetor
- Gasket Kit
- High Altitude Carburetor Kit

ENGINE - KAWASAKI (AIR-COOLED) COMPONENT LOCATION

Component Location

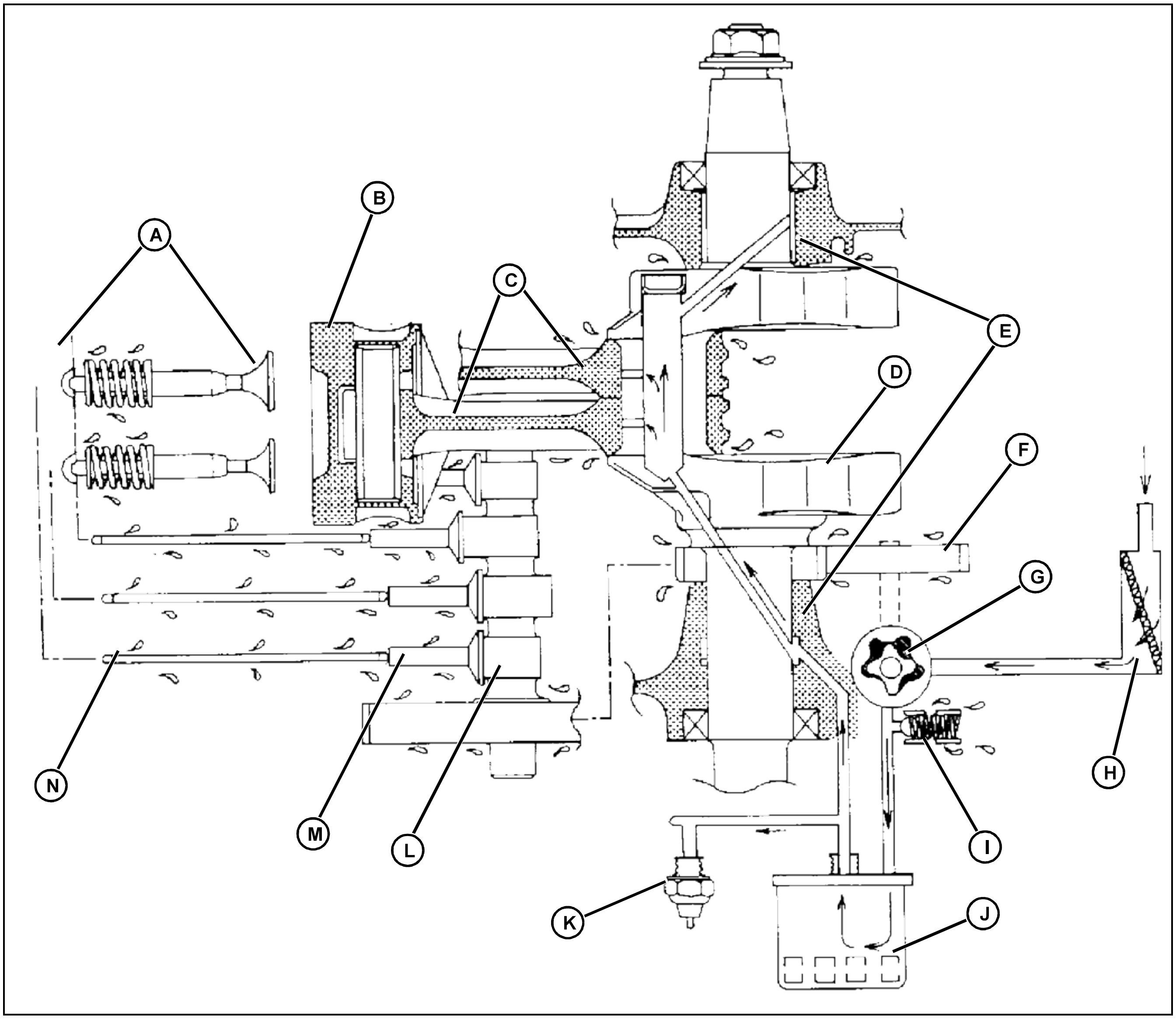
Engine Components



M95399/M95400

- **A - Blower Housing**
- **B - Ignition Module**
- **C - Screen**
- **D - Blower Fan**
- **E - Flywheel**
- **F - Stator**
- **G - Dipstick**
- **H - Oil Pressure Switch**
- **I - Oil Filter**
- **J - Crankcase**
- **K - Drain Plug**
- **L - Governor Linkage**
- **M - Throttle and Choke Linkage**
- **N - Throttle Control Panel**
- **O - Spark Plug**
- **P - Rocker Arm Cover**
- **Q - Vacuum Hose**
- **R - Fuel Pump**
- **S - Air Cleaner Housing**
- **T - Air Cleaner Cover**
- **U - Carburetor Inlet Hose**
- **V - Carburetor**
- **W - Fuel Shutoff**
- **X - Voltage Regulator/Rectifier**
- **Y - Starting Motor**

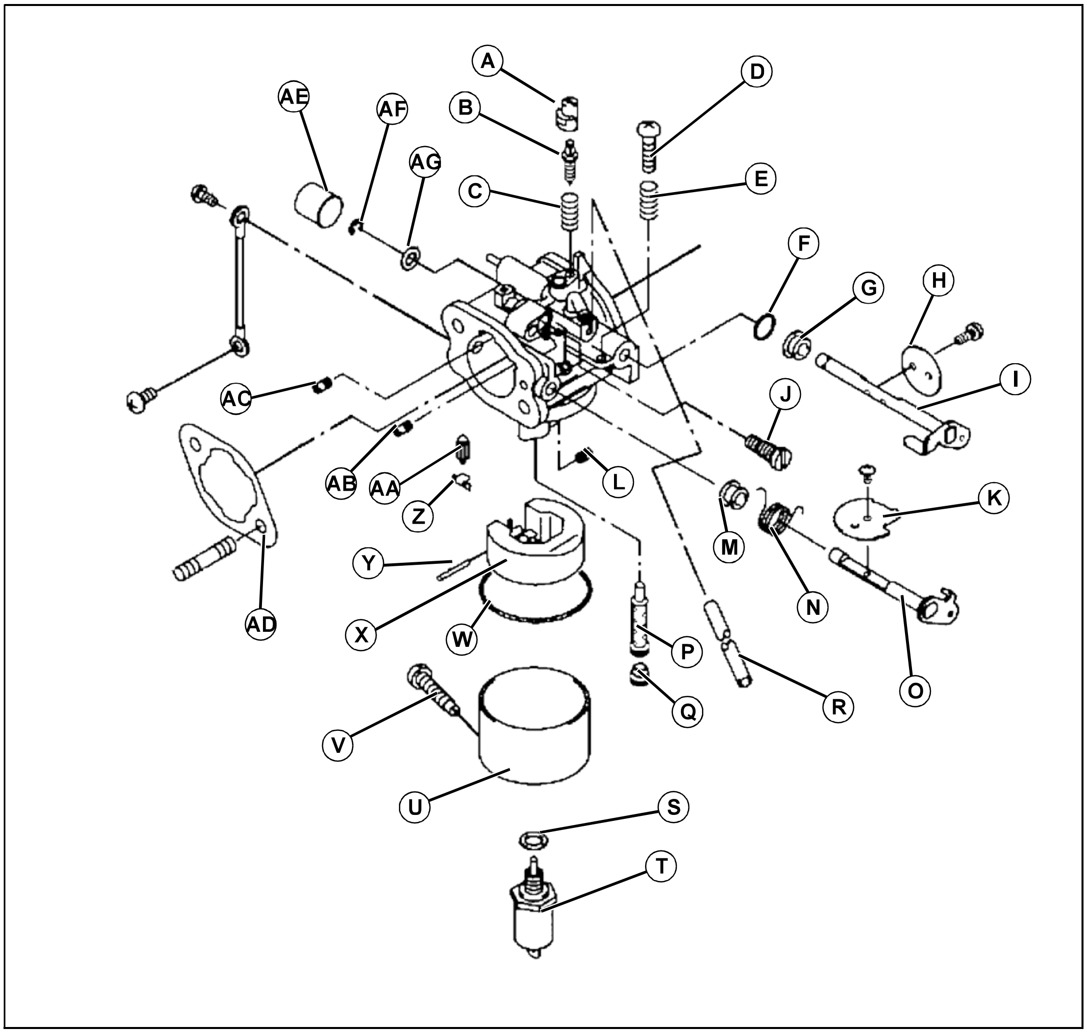
Engine Oil Flow Chart



M99565

A - **Rocker Arms and Valves**
B - **Pistons**
C - **Connecting Rods**
D - **Crankshaft**
E - **Crankshaft Main Bearings**
F - **Oil Pump Gear**
G - **Oil Pump**
H - **Pick-up Screen**
I - **Oil Pressure Relief Valve**
J - **Oil Filter**
K - **Oil Pressure Sensor**
L - **Camshaft**
M - **Tappets**
N - **Push Rods**

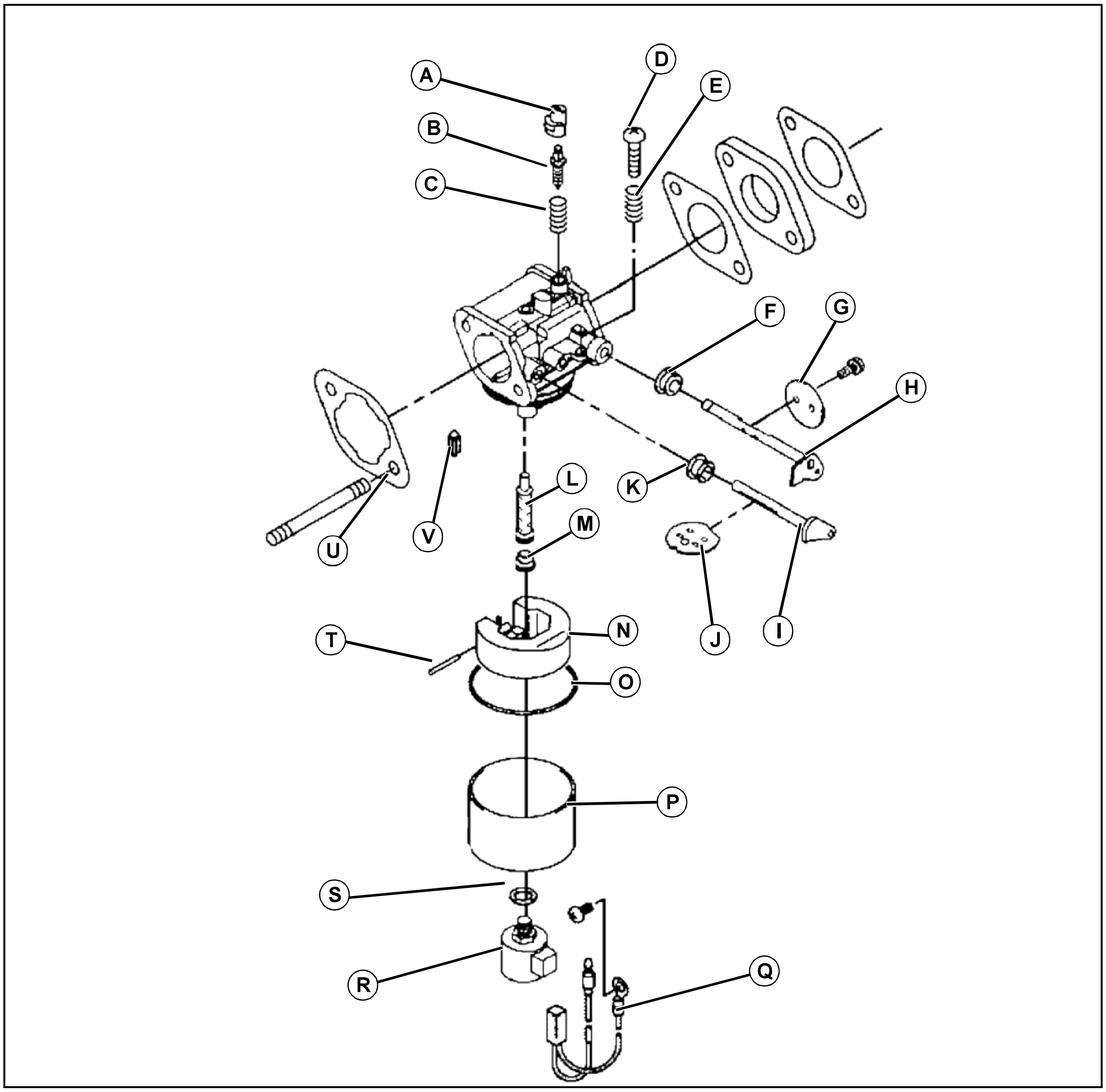
Carburetor Components (LX277 - FH500V)



M94903

A - Limiter
B - Pilot Air Screw
C - Spring
D - Low Idle Screw
E - Spring
F - Seal
G - Ring
H - Throttle Valve
I - Throttle Shaft
J - Pilot Jet
K - Choke Valve
L - Main Jet
M - Collar
N - Spring
O - Choke Shaft
P - Main Nozzle
Q - Valve Seat
R - Tube
S - Washer
T - Fuel Shutoff Solenoid
U - Float Bowl
V - Drain Screw
W - Gasket
X - Float
Y - Pin
Z - Snap Ring
AA- Float Valve
AB- Main Air Jet
AC- Air Jet
AD- Gasket
AE- Cap
AF- E-clip
AG- Washer

Carburetor Components (LX288 - FH580V)



MX19760

A - **Limiter**
B - **Pilot Air Screw**
C - **Spring**
D - **Low Idle Screw**
E - **Spring**
F - **Seal**
G - **Throttle Valve**
H - **Throttle Shaft**
I - **Choke Shaft**
J - **Choke Valve**
K - **Seal**
L - **Main Nozzle**
M - **Valve Seat**
N - **Float**
O - **Gasket**
P - **Float Bowl**
Q - **Solenoid Harness**
R - **Fuel Solenoid**
S - **Gasket**
T - **Pin**
U - **Gasket**
V - **Float Valve**

Theory of Operation

Lubrication System Operation

Function:

To provide pressurized oil to lubricate internal engine components.

Theory of Operation:

A positive displacement gerotor pump is used to pressurize the lubrication system. The lubrication system is protected by an oil pressure relief valve, low oil pressure switch, and an oil filter with bypass valve.

The oil pump draws oil from the sump through the pick-up screen. Pressure oil from the pump flows through the pump outlet passage past the oil pressure relief valve. The oil pressure relief valve limits the oil pressure to approximately 296 kPa (43 psi) and protects the oil pump from damage if an oil passage becomes blocked. If the oil pressure exceeds 296 kPa (43 psi), the relief valve opens allowing oil to return to the sump. The relief valve is not adjustable.

Pressure oil flows past the relief valve to the oil filter. The filter contains a bypass valve which opens at 78.5 - 117.5 kPa (11.4 - 17.1 psi) if the element becomes plugged to ensure engine lubrication.

An oil pressure switch mounted above the oil filter turns on a warning light if oil pressure is below 98 kPa (14.2 psi). Filtered pressure oil flows through a passage in the oil sump to the crankshaft main bearing (PTO side). Drilled passages in the crankshaft distribute oil from the main bearings to the connecting rod journals and crankshaft main bearings (flywheel side). A drilled passage in the connecting rods allows oil from the connecting rod journal to lubricate the piston and cylinder walls.

In the cylinder head, the rocker arms, valves, and pushrods are lubricated by an oil/air mixture carried through an upper lubrication passage from the breather chamber. As this oil/air mixture is swirled around the rocker arm chamber, the oil particles cling to the moving parts, lubricating them. Eventually these oil particles collect into a liquid state again in the lower portion of the rocker arm chamber. A small return passage is provided to return this liquid state oil back into the crankcase.

The camshaft gear, camshaft, tappets, coolant pump gear, governor gear, oil pump gear, and crankshaft gear are lubricated by oil splash generated by the internal moving parts during operation.

Diagnostics

Engine Troubleshooting Guide

CAUTION: Avoid Injury! The engine may start to rotate at any time. Keep hands away from moving parts when testing.

NOTE: To test specific electrical components, see Electrical Section and refer to either Diagnostics or Tests & Adjustments for further guidance.

Test Conditions:

- Operator On Seat
- PTO Switch In Off Position
- Brake On

Symptom: Engine Doesn't Crank

(1) Are battery cables loose or dirty?

Yes - Tighten or clean.

No - Go to next step.

(2) Is battery fully charged? See "Battery Voltage and Specific Gravity Test" on page 330.

No - Charge battery. See "Battery - Charge" on page 331 in the Electrical section.

Yes - Go to next step.

(3) Is key switch working correctly?

Yes - Go to next step.

No - Test switch. See "Ignition Circuit Diagnosis - LX255, LX266, LX277 and LX288" on page 284 or "Ignition Circuit Operation - LX279" on page 287 in the Electrical section. Replace as needed.

(4) Has engine seized?

Yes - See Engine Repair Section.

No - Go to next step.

(5) Is starting motor or solenoid defective?

Yes - Repair or replace. See "Starting Motor Disassembly and Assembly" on page 117 or "Starting Motor" on page 350 in the Electrical section.

Symptom: Engine Hard To Start

(1) Is there a strong blue spark? See "Spark Test" on page 91.

Yes - Go to step 3.

Symptom: Engine Hard To Start

No - Replace spark plug. Recheck for spark and go to next step.

(2) Is there a strong blue spark?

Yes - Check engine starting.

No - Check if sparks are produced between high tension lead and ignition block. Check high tension lead, ignition coil air gap, pulser coil.

(3) Check compression. See "Cylinder Compression Pressure Test" on page 87. Is compression sufficient?

Yes - Make starting attempts a number of times, remove spark plug and observe electrodes. Go to next step.

No - Go to step 5.

(4) After starting attempts, are spark plug electrodes wet?

Yes - Check for excessive use of choke, plugged air cleaner, float bowl level too high.

No - Check fuel tank and lines.

(5) Compression is low?

Yes - Check piston rings and cylinder for wear. See "Piston Inspection:" on page 106. Inspect cylinder head. and "Cylinder Head Inspection" on page 101.

CAUTION: Avoid injury! Keep spark plug as far away from the plug hole as possible. Gasoline spray from the open cylinders may be ignited by ignition spark and cause an explosion or fire.

Symptom: Engine Malfunctions At Low Speed

(1) Is unusual smoke emitted out of muffler?

Yes - Check choke. See "Choke Plate Check and Adjustment" on page 83.

No - Go to next step.

(2) Does engine rpm drop or engine stall at a certain point when throttle is gradually opened by hand?

Yes - Plug in carburetor interior, clean carburetor. See "Carburetor Disassembly and Assembly" on page 95.

No - Go to next step.

Symptom: Engine Malfunctions At Low Speed

(3) Is air sucked through carburetor or intake manifold flanges?

Yes - Tighten manifold flange nuts or replace damaged gasket.

No - Go to next step.

(4) Are valve clearances set correctly? See "Valve Clearance Check and Adjustment" on page 86.

No - Adjust valves.

Symptom: Engine Runs Erratically

(1) Is fuel delivery correct. See "Fuel Pump Test" on page 90.

Yes - Check for plugged air/fuel passages in carburetor. See "Carburetor Disassembly and Assembly" on page 95.

No - Check for contamination, or an air or vapor lock in the fuel tank and lines.

Symptom: Oil Consumption Is Excessive

(1) Check compression. See "Cylinder Compression Pressure Test" on page 87. Is compression sufficient?

Yes - Check for oil leaks, high oil level, plugged oil ring groove, oil seals, clogged breather valve, plugged drain back hole in breather, incorrect oil viscosity.

No - Check for worn, stuck or broken piston rings, or worn cylinder bore.

Starting Motor Troubleshooting Guide

CAUTION: Avoid Injury! The engine may start to rotate at any time. Keep hands away from moving parts when testing.

IMPORTANT: Avoid damage! If starting motor does not by turning ignition switch to Off position, disconnect negative (-) lead from battery as soon as possible.

NOTE: To test specific electrical components, see Electrical Section and refer to either Diagnostics or Tests & Adjustments for further guidance.

Symptom: Starter Does Not Rotate

(1) Is there a click sound from starter solenoid?

Symptom: Starter Does Not Rotate

Yes - Repair starting motor. See “Starting Motor Disassembly and Assembly” on page 117, and “Starting Motor” on page 350 in the Electrical section.

No - Check that all starting conditions are met. Go to next step.

(2) Are battery cables loose or dirty?

Yes - Tighten or clean.

No - Go to next step.

(3) Is battery fully charged? See “Battery Voltage and Specific Gravity Test” on page 330 in the Electrical section.

No - Charge battery. See “Battery - Charge” on page 331 in the Electrical section.

Yes - Go to next step.

(4) Is key switch working correctly?

Yes - Go to next step.

No - Test switch. See “Ignition Circuit Diagnosis - LX255, LX266, LX277 and LX288” on page 284 or “Ignition Circuit Operation - LX279” on page 287 in the Electrical section.

(5) Has engine seized?

Yes - See Engine Repair Section.

Symptom: Starter Rotates Slowly

(1) Are battery cables loose or dirty?

Yes - Tighten or clean.

No - Go to next step.

(2) Is battery fully charged? See “Battery Voltage and Specific Gravity Test” on page 330 in the Electrical section.

Yes - Go to next step.

No - Charge battery. See “Battery - Charge” on page 331 in the Electrical section.

(3) Has engine seized?

Yes - See Engine Repair Section.

No - Go to next step.

(4) Is starting motor or solenoid defective?

Yes - Repair or replace. See “Starting Motor Disassembly and Assembly” on page 117 or “Starting Motor” on page 350 in the Electrical section.

Tests and Adjustments

Throttle Cable Adjustment

Reason:

To make sure the throttle control arm contacts the slow idle stop at slow idle.

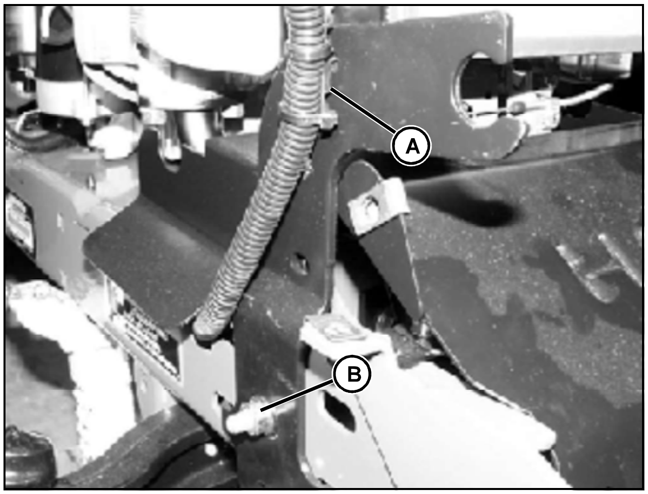
Equipment:

- 6 mm (15/64-in.) Drill Bit

Procedure:

1. Park machine on a flat surface. Turn engine OFF, and lock parking brake.

2. Remove hood. See “Hood Removal and Installation” on page 589 in the Miscellaneous section.

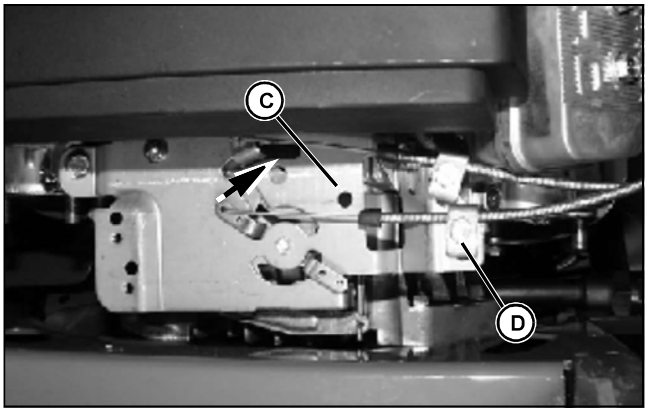


M99525

3. Remove headlight wiring harness clip (A) from frame.

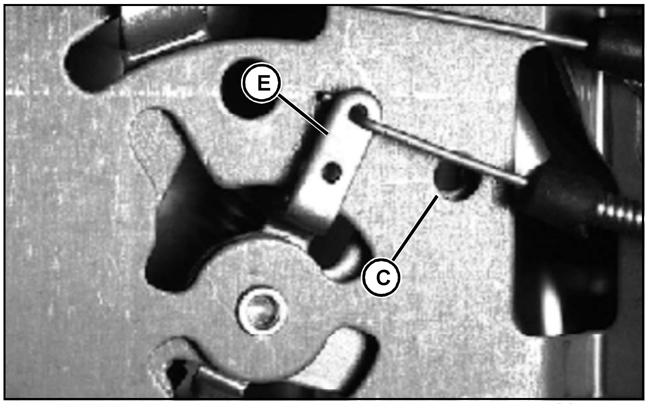
4. Remove two flange nuts (B) securing hood support brackets. Remove brackets.

5. Remove four cap screws and upper heat shield.



M99555

6. Loosen throttle cable clamp (D).



M99558

7. Align the hole (C) in the speed control lever (E) with the hole in the base plate by moving the speed control lever.

8. Insert a 6 mm (0.24 in.) pin or bolt through the base plate and speed control lever holes.

9. Pull up the cable housing until there is almost no slack in the throttle cable, and tighten throttle cable clamp.

10.Remove pin or bolt.

11.Install upper heat shield and hood brackets.

12.Install hood.

Choke Cable Adjustment

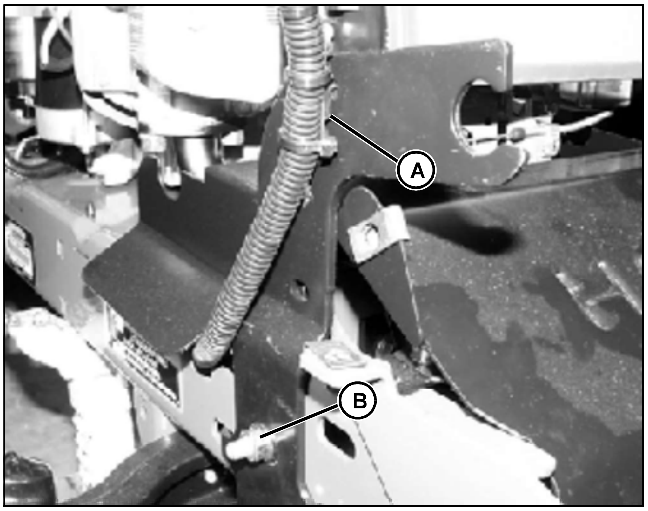
Reason:

To make sure the choke is fully closed when the choke control lever is in the full choke position.

Procedure:

1. Park machine on a flat surface. Turn engine OFF, and lock parking brake.

2. Remove hood. See “Hood Removal and Installation” on page 589 in the Miscellaneous section.

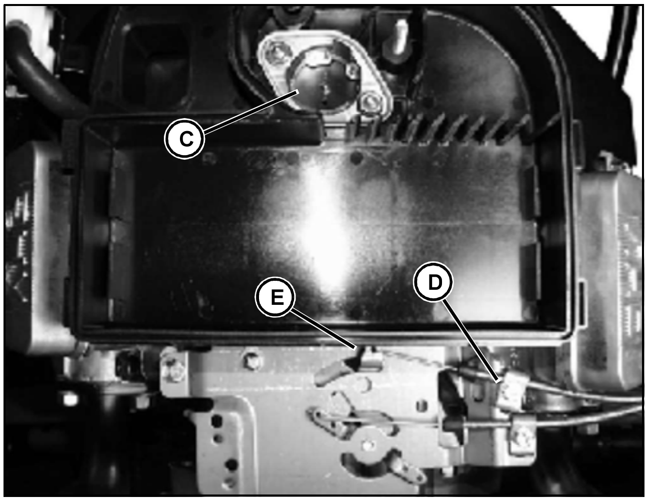


M99525

3. Remove headlight wiring harness clip (A) from frame.

4. Remove two flange nuts (B) securing hood support brackets. Remove brackets.

5. Remove four cap screws and upper heat shield.



M99557

6. Remove air cleaner cover and filter.

7. Loosen choke cable clamp (D).

8. Place and hold the choke control lever (E) in the full choke position.

9. Move the engine choke lever until the carburetor choke plate (C) is fully closed. Tighten choke cable clamp.

NOTE: If the choke will not fully close when the engine choke lever is fully rotated clockwise, perform "Choke Plate Check And Adjustment" below.

10.Move the choke control lever between the choke fully open and fully closed position several times. Ensure the choke plate fully opens and closes. Readjust cable as needed.

11.Install the air filter and air cleaner cover.

12.Install the upper heat shield and hood brackets.

13.Install the hood.

Choke Plate Check and Adjustment

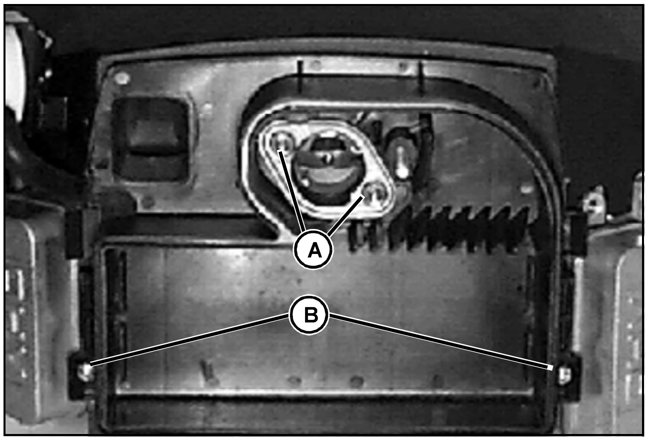
Reason:

To make sure the choke plate is fully closed when the choke control lever is in the full choke position.

CHECK Procedure:

IMPORTANT: Avoid damage! Check and adjust choke cable before adjusting choke, to ensure accurate adjustment.

1. Check and adjust choke cable.



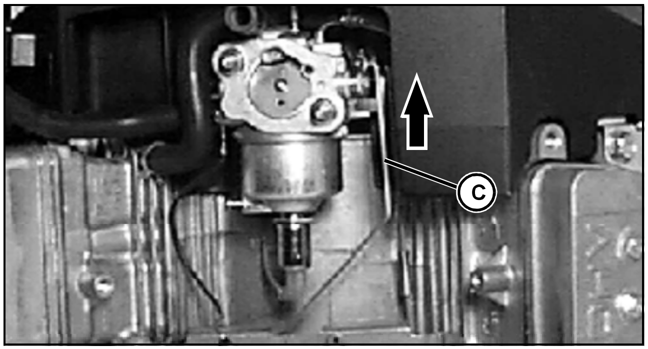
M95366

2. Remove the two screws (B) and two nuts (A) that hold the air cleaner base to the carburetor.

3. Carefully pull air cleaner base away from carburetor and remove crankcase vent tube from back of air cleaner base.

4. Place both nuts back on carburetor studs and secure finger tight only.

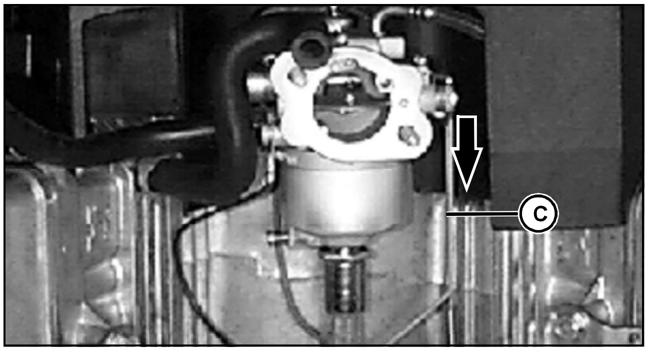
5. Move throttle control lever to full CHOKE position.



M95376

6. Try to move choke rod (C) toward carburetor (arrow). Choke rod should NOT move. If choke rod moves up, the choke plate is not fully closed.

7. Move choke control lever to fully open position.



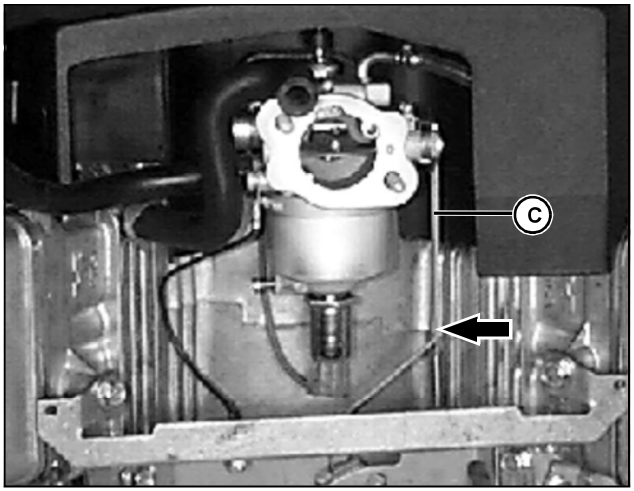
M95376

8. Try to move choke rod (C) down (arrow). Choke rod should NOT move. If choke rod moves down, the choke plate is not fully open.

Results:

- If choke rod DOES NOT move in either direction with choke control lever in the specific positions, choke operation is OK.
- If choke rod MOVES in either direction with throttle control lever in the specific positions, perform ADJUSTMENT procedure.

Adjustment Procedure:



M95379

1. Carefully bend the choke rod (C) at the corner (arrow) to balance the open and closed position of the choke valve plate.

2. Bending the rod more will open the choke, while bending the rod straighter will close the choke valve.

3. Repeat CHECK Procedure.

4. Install air cleaner housing. Tighten nuts securing housing and carburetor to 6.9 N•m (61 lb-in.), and screws securing housing to 3.9 N•m (35 lb-in.).

5. Install hood.

Governor Adjustment

Reason:

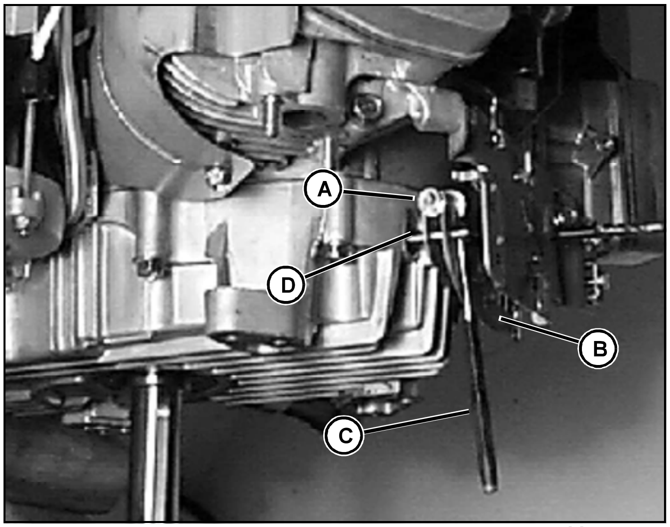
To ensure the governor shaft contacts the fly-weight plunger when the engine is stopped.

Procedure:

NOTE: Adjust throttle cable and choke plate before adjusting governor linkage.

1. Adjust throttle cable and choke plate.

2. Move throttle control lever to FAST idle position.



M95384

3. Loosen nut (A).

4. Hold governor arm (B) in the fully clockwise.

5. Using a small pin (C), rotate shaft (D) counterclockwise as far as it will go.

6. Hold governor shaft and governor arm in place and tighten nut to 7.8 N•m (69 lb-in.).

7. Move throttle control lever through full range to be sure linkage is not binding.

Slow Idle Speed Adjustment

Reason:

The slow idle speed is not adjustable. Slow idle is governed at 1550 ± 75 rpm.

The idle mixture screw can be adjusted within limiter range, and the slow idle stop can be set.

Equipment:

- JT07270 Digital Pulse Tachometer; or,
- JT05719 Photo Tachometer

Procedure:

1. Park machine on level surface.

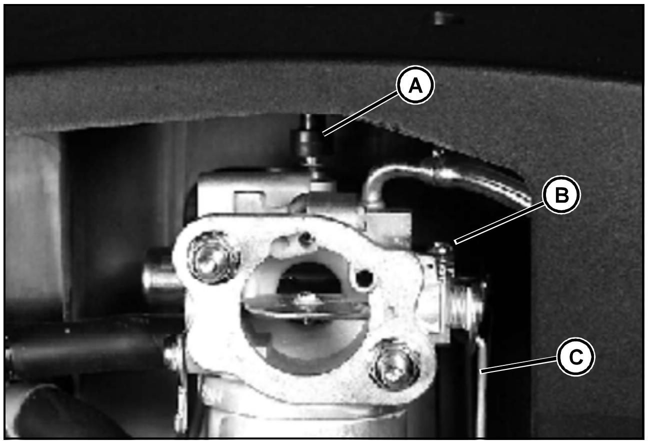
2. Turn key switch OFF.

3. Move forward/reverse pedals to NEUTRAL position. Lock parking brake.

4. Raise hood.

5. Put reflective tape (for photo tachometer) on blower housing screen.

NOTE: Idle mixture is factory set. Access idle mixture screw and slow idle stop screw through holes in front shroud. DO NOT force the idle mixture screw.



M99560

Air Filter and Housing Removed for Clarity.

6. Start and run engine at MEDIUM idle for five minutes.

7. Move throttle control lever to SLOW idle position.

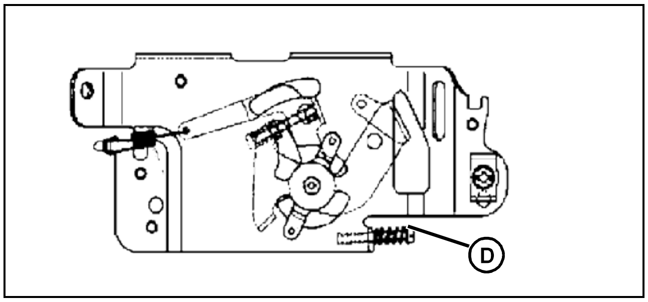
8. Initial Adjustment: Turn idle mixture screw (A) clockwise until it contacts the limiter stop. Then turn idle mixture screw counterclockwise (approximately 1/2 turn) until it contacts the limiter stop. Turn idle mixture screw clockwise to midpoint.

9. Turn idle mixture screw until best idle is obtained.

10.Pull throttle lever rod (C) down until movement stops (holds the throttle lever on the carburetor in the closed position and turns the governor arm clockwise all the way) when the idle stop screw (B) is contacted.

11.While maintaining contact (downward pressure), turn SLOW idle stop screw (B) counterclockwise until slow idle speed is 1450 rpm.

NOTE: Idle speed is governed at 1550 ± 75 rpm. When throttle lever rod is released, the idle stop screw should not be in contact with throttle rod.



M99560

12.Release the throttle and adjust the low idle speed screw on the control plate (D) until the engine idles at 1550 ± 75 rpm.

Fast Idle Speed Adjustment

Reason:

To set engine fast idle speed setting.

Equipment:

- 6 mm (15/64 in.) Drill Bit; or,
- 6 x 30 mm Flat Head Pin (45M7036)
- JT07270 Digital Pulse Tachometer; or,
- JT05719 Photo Tachometer

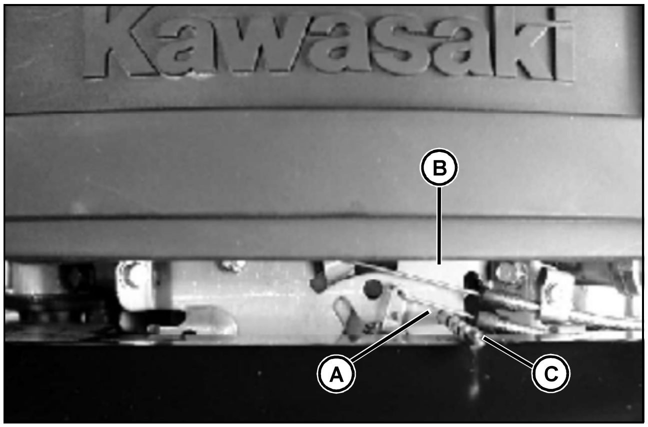
Procedure:

Before performing this procedure, adjust slow idle speed. See “Slow Idle Speed Adjustment” on page 85.

1. Park machine on level surface.
2. Turn key switch OFF.
3. Move forward/reverse pedals to NEUTRAL position. Lock parking brake.
4. Remove hood.
5. Put reflective tape (for photo tachometer) on blower housing screen.
6. Start and run engine at MEDIUM idle for five minutes to warm engine.

CAUTION: Avoid injury! Engine will be HOT. Be careful not to burn hands

7. Move throttle control lever to FAST idle position.



M99561

8. Align hole in throttle arm (A) with hole in throttle control panel (B). Put a 6 mm (15/64-in.) drill bit or 6 mm pin (C) through holes to keep the throttle control arm from moving. Be sure drill bit is perpendicular to the throttle control panel.
9. Use Photo Tachometer to check engine rpm. Fast idle speed setting should be 3350 ± 50 rpm.

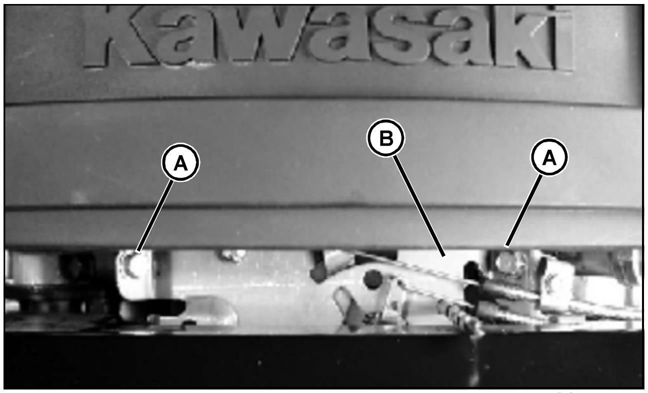
Results:

If fast idle speed does not meet the specifications:

- Adjust throttle control panel

NOTE: Moving the control panel changes the governor spring tension to adjust fast idle.

IMPORTANT: Avoid damage! DO NOT adjust high idle speed with the air cleaner removed.



M99561

1. Loosen cap screws (A).
2. Move left side of throttle control panel (B) up to increase rpm or down to decrease rpm.
3. Hold the throttle control panel and tighten cap screws to 6.9 N•m (61 lb-in.).
4. Remove the 6 mm (15/64-in.) drill bit or pin.
5. Check fast idle speed, and readjust the idle speed as necessary.
6. Stop engine. Install hood.

Valve Clearance Check and Adjustment

Reason:

To obtain the proper valve clearance that is critical for the valves to seat properly.

Equipment:

- Feeler Gauge (blade type)

Procedure:

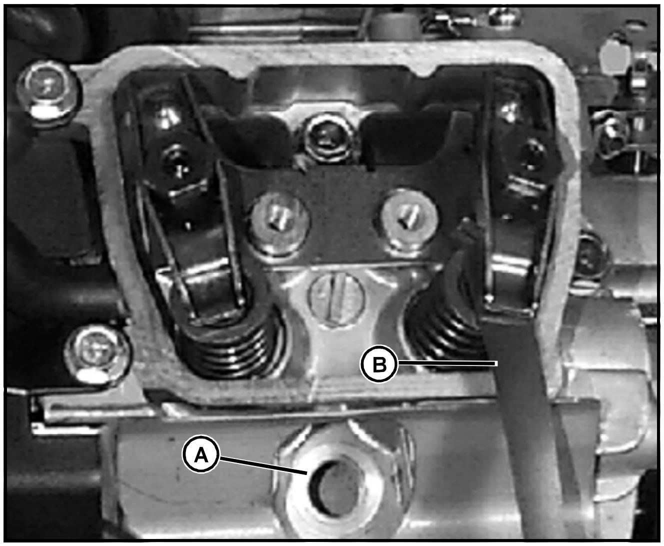
IMPORTANT: Avoid damage! Perform valve clearance check or adjustment when engine is cold.

1. Park machine on level surface.
2. Turn key switch OFF. Allow engine to cool.
3. Move forward/reverse pedals to NEUTRAL position. Lock parking brake.

4. Raise hood.

5. Remove and ground spark plug lead. Remove spark plug.

6. Remove valve cover.

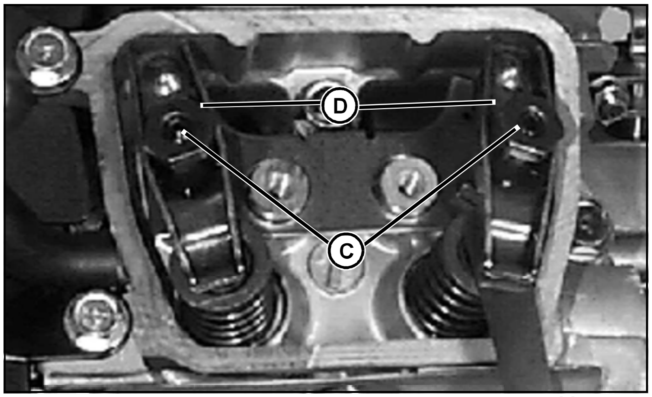


M95401

7. Turn crankshaft until piston, visible in spark plug hole (A), is at TDC (top dead center) of the compression stroke (both intake and exhaust valves will be closed).

8. Use a feeler gauge (B) to measure valve clearance. Valve clearance should be to specification.

Results:



M95401

1. If valve clearance does not meet the specifications, loosen lock screws (C). Turn adjusting nut (D) to adjust valve clearance to specifications.

2. Hold adjusting nut and tighten lock screw to 6.9 N•m (61 lb-in.). Check clearance again.

Specifications:

Intake and Exhaust Valve Clearance (cold)
(FH580V, SN 090001-) . 0.10 - 0.15 mm (0.004 - 0.006 in.)
(FH500V) . . . . 0.05 - 0.1 mm (0.002 - 0.004 in.)
Jam Nut (C) Torque . . . . 6.9 N•m (61 lb-in.)
Valve Cover Cap Screw Torque . . . . 6.9 N•m (61 lb-in.)
Spark Plug Torque (FH500V) . . . . . . 15 N•m (130 lb-in.)
Spark Plug Torque (FH580V). . . . . . . 22 N•m (195 lb-in.)

Cylinder Compression Pressure Test

Reason:

To determine the condition of the pistons, rings, cylinder walls, and valves.

Test Equipment:

- JDM59 Compression Gauge

Procedure:

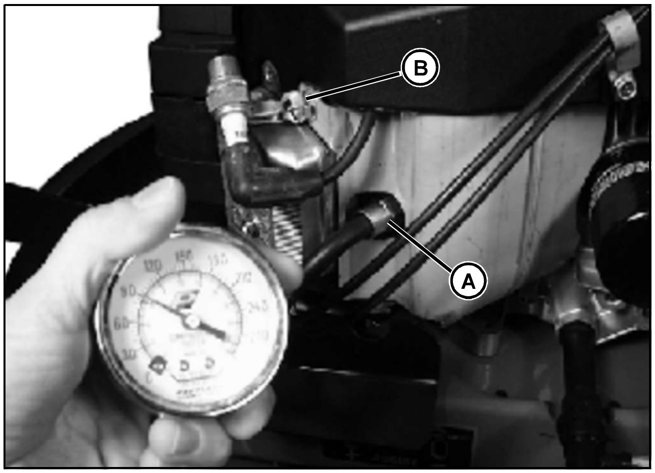
1. Valve clearance must be adjusted properly before doing a compression test.

2. Run engine for five minutes to bring engine to operating temperature.

3. Park machine on level surface and turn key switch OFF.

4. Move forward/reverse pedals to NEUTRAL position.

5. Lock parking brake, raise hood and remove spark plugs.



M99562

6. Install JDM59 Compression Gauge (A) in one spark plug hole.

7. Ground high tension leads (B) or disconnect positive lead from ignition coil.

8. Move throttle control lever to FAST idle position.

9. Check that choke is fully open and that air filter is clean.

IMPORTANT: Avoid damage! DO NOT overheat starting motor during test. Starter duty cycle is 5 seconds ON, 10 seconds OFF.

10.Crank engine for three to five compression strokes.

11.Record pressure reading.

12.Repeat test with other cylinder.

Specifications:

Minimum Compression . . . . 390 kPa (57 psi)

Maximum difference between cylinders. . 41 kPa (6 psi)

Results:

NOTE: Above specifications are for an engine that has sufficient time to allow rings to fully seat.

Compression that is lower than specifications on low hour machines (but relatively equal on both cylinders) probably does not indicate a problem.

- If above specification, adjust valves and check fuel and air intake systems. Check exhaust for restriction.
- If below specification, squirt clean engine oil into cylinder and repeat test.
- If compression pressure does not increase after retest: check for leaking valves, valve seats, or cylinder head gaskets.
- If compression pressure increases after retest: check rings, pistons, and cylinder bores for broken rings, scoring, wear or damage. Replace as necessary.

Crankcase Vacuum Test

Reason:

To measure the amount of crankcase vacuum, which ensures the crankcase is not pressurized. A pressurized crankcase will force oil leakage past the seals and gaskets and affect fuel pump operation.

Test Equipment:

- 8741-F66 Plug
- JT05703 Barb Fitting
- JT05699 Line
- JT05698 U-Tube Manometer

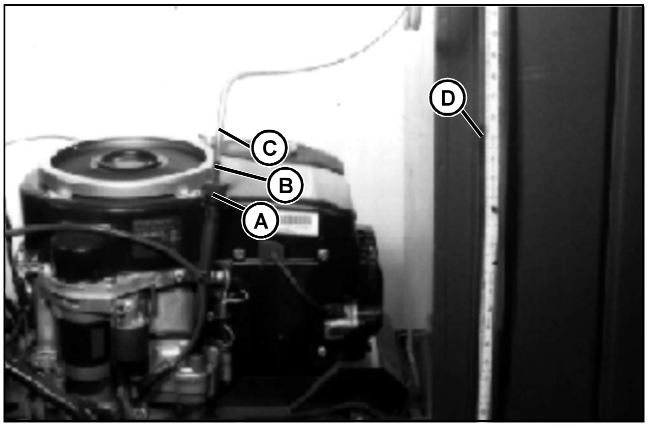
or,

- JT03503 Crankcase Vacuum Test Kit

Procedure Using JT05698 U-Tube Manometer:

1. Park machine on level surface.
2. Turn key switch OFF.
3. Move forward/reverse pedals to NEUTRAL position. Lock parking brake.
4. Raise hood.
5. Remove dipstick.
6. Install 8741-F66 Plug (A) in dipstick hole.
7. Install JT05703 Barbed Fitting (B) in Plug and connect JT05699 Line (C).

IMPORTANT: Avoid damage! DO NOT make connection between U-Tube Manometer (D) and Line (C) BEFORE engine is running or fluid in Manometer could be sucked into crankcase. DO NOT turn engine OFF until Line (C) has been disconnected from Manometer.



M45642

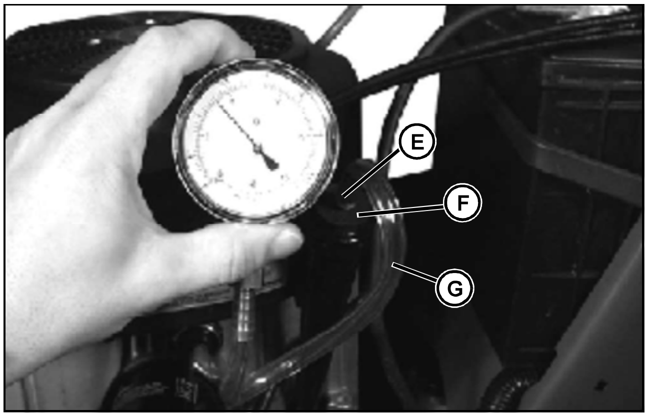
A - Plug
B - Barb Fitting
C - Line
D - U-Tube Manometer

8. Start and run engine at slow idle.
9. Connect JT05698 Manometer (D) to Line (C).
10. Run engine at fast idle.
11. Open Manometer vent and record crankcase vacuum reading. Manometer should show a vacuum of 1.25 - 25 cm (0.5 - 10 in.) of water at fast idle.
12. Run engine at slow idle. DO NOT TURN ENGINE OFF!
13. Disconnect Line (C) from Manometer (D).
14. Turn engine OFF.
15. Remove Barbed Fitting and Plug from dipstick tube and install dipstick.

Procedure Using JT03503 Crankcase Vacuum Kit:

1. Park machine on level surface.
2. Raise engine hood and remove dipstick. Check dipstick/ oil fill cap and o-ring for cracks or damage, replace as necessary.
3. Install appropriate size rubber plug in dipstick tube.
4. Insert barbed fitting (E) in rubber plug (F) so that clear line (G) to fitting can be connected at a later step.

IMPORTANT: Avoid damage! DO NOT make connection between test gauge and rubber plug BEFORE engine is running at FAST idle or gauge damage may result.
After test reading is made, DO disconnect test gauge WHILE engine is running at FAST idle to prevent damage to gauge.



M99563

5. Hold finger over rubber plug hole to keep oil from spraying out. Start engine, move the throttle lever to fast idle and allow engine to reach operating temperature.

6. Connect gauge, clear line (G), and barbed fitting (E) to rubber plug (F).

7. Record crankcase vacuum reading. Gauge should show a vacuum of 1.27 - 25.4 cm (0.5 - 10 in.) of water at fast idle.

8. Disconnect barbed fitting, clear line, and gauge from rubber plug while engine is running at FAST idle. Hold finger over rubber plug hole to keep oil from spraying out.

9. Move throttle to SLOW idle and turn engine OFF.

10.Remove rubber plug and install dipstick.

Specification:

Crankcase Vacuum at
3350 ± 50 rpm . . . . 1.27 - 25.4 cm (0.5 - 10 in.) of water

NOTE: A new engine may have low vacuum readings due to the fact that the rings are not seated.

Results:

- If crankcase vacuum is BELOW specifications, check the following:
  - ☐ Breather reed valve clearance and condition.
  - ☐ Seals and gaskets for leakage.
  - ☐ Fuel pump vacuum hose leakage.
  - ☐ Rocker arm cover O-ring for leakage.
  - ☐ Rings, piston, and cylinder bore for wear or damage.

Engine Oil Pressure Test

Reason:

To verify if the engine has enough oil pressure to lubricate internal components.

Test Equipment:

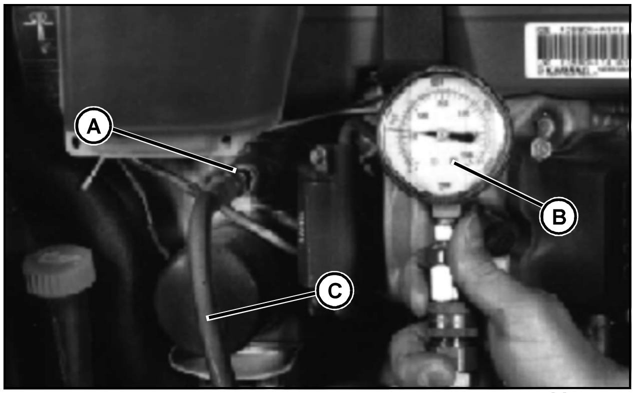
- JT03344 Pressure Gauge Assembly
- JT03017 Hose Assembly
- JT03349 Connector

Procedure:

1. Park machine on level surface.
2. Turn key switch OFF. Allow engine to cool.
3. Move forward/reverse pedals to NEUTRAL position.
4. Lock parking brake.
5. Raise hood.

CAUTION: Avoid Injury! Engine components are HOT. Be careful not to touch, especially the exhaust pipe or muffler while making adjustments. Wear protective eye glasses and clothing.

6. Check engine oil level, bring level to full mark.
7. Remove oil pressure switch.



M49880

8. Install JT03349 Connector (A).

9. Connect JT03017 Hose Assembly (C) and JT03344 Pressure Gauge Assembly (B).

10.Monitor oil pressure while cranking engine. If no oil pressure is present, discontinue cranking engine. Determine and correct cause before running engine.

IMPORTANT: Avoid damage! If pressure reading is below 69 kPa (10 psi), STOP ENGINE IMMEDIATELY and determine cause.

11.Start and run engine at MEDIUM idle for five minutes to heat engine oil to normal operating temperature.

12.Run engine at fast idle and check oil pressure. Gauge should read an oil pressure of 241 - 310 kPa (35 - 45 psi).

Results:

If oil pressure is BELOW specifications, inspect or replace the following:

- Oil pressure relief valve for broken or worn spring.
- Oil pressure relief valve for stuck or damaged valve.
- Worn or damaged oil pump.
- Oil pump suction screen or oil passages plugged.
- Excessive wear of connecting rod and main bearing journals.
- Oil filter plugged.

Specifications:

Oil Pressure

Minimum . . . . 69 kPa (10 psi)

Fast Idle. . . . . 241 - 310 kPa (35 - 45 psi)

Fuel Pump Test

Reason:

To check condition of fuel pump and determine fuel pressure.

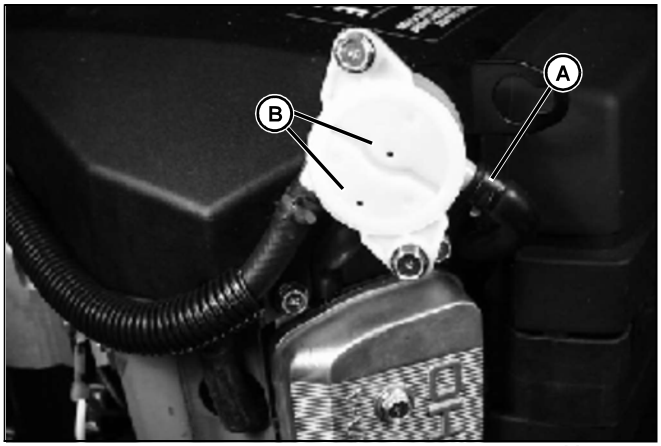
Test Equipment:

- JDG356 Pressure Gauge
- Graduated Container

Procedure:

1. Park machine on level surface.
2. Turn key switch OFF.
3. Move forward/reverse pedals to NEUTRAL position. Lock parking brake.
4. Raise hood.
5. Start and run engine at slow idle for one minute to fill carburetor with fuel.
6. Stop the engine.

CAUTION: Avoid Injury! Gasoline is extremely flammable. DO NOT SMOKE. Always work in a well ventilated area away from open flame or spark producing equipment; this includes equipment that utilizes pilot lights.



M99564

7. Disconnect and plug fuel pump outlet hose (A).
8. Connect JDG356 Pressure Gauge to fuel pump outlet (B).
9. Start and run engine at fast idle for 15 seconds, then record pressure reading. Gauge should read a minimum pressure of 6.12 kPa (0.9 psi).
10. Stop engine.
11. Remove pressure gauge from fuel pump outlet and connect a length of hose long enough to reach into a graduated container.
12. Start and run engine at fast idle for 15 seconds, then stop the engine and record container measurement. Minimum flow is 54.2 ml/15 seconds (1.8 oz/15 seconds).

Results:

If fuel pump pressure or flow does not meet the specifications, check the following:

- Fuel lines, filter and fuel tank cap for restrictions.
- Check crankcase vacuum.
- Check vent holes (B) for plugging or clogging.
- Replace fuel pump.

Specifications:

Minimum Fuel Pressure. . . . . 6.12 kPa (0.90 psi)

Minimum Fuel Flow . . . . 54.2 mL/15 seconds
. . . . . (1.8 oz/15 seconds)

Spark Test

Reason:

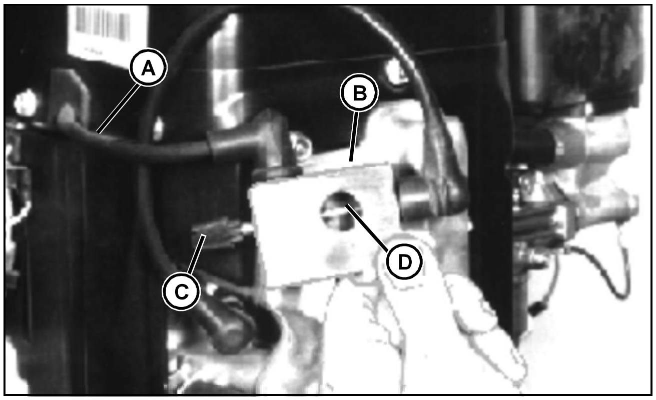
Check overall condition of ignition system.

Test Equipment:

- D-05351ST Spark Tester

Procedure:

1. Park machine on level surface.
2. Turn key switch OFF.
3. Move forward/reverse pedals to NEUTRAL position. Lock parking brake.
4. Raise hood.



M49887

5. Remove high tension lead (A) from spark plug.
6. Connect D-05351ST Spark Tester (B) to spark plug.
7. Connect high tension lead to Spark Tester.

IMPORTANT: Avoid damage! Do not adjust spark tester gap beyond 5.0 mm (0.200 in.) (5 turns), as damage to ignition components could occur.

8. Adjust spark tester gap to 4.2 mm (0.166 in.) (4 turns) with screw (C).
9. Move key switch to RUN position.
10. Spin engine with starter and watch spark (D) at spark tester. If engine will start, watch spark with engine running. A steady, strong, blue spark should be observed.

Results:

- If spark is weak, or no spark is present, install a new spark plug and repeat test.
- If spark is still weak, or no spark is present, run tests on individual components to find the cause of the malfunction.

Spark Plug Gap Adjustment

Equipment:

- Feeler Gauge, or
- Wire Gauge

Procedure:

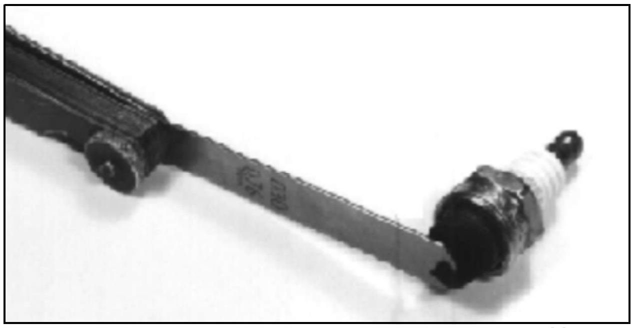
1. Park machine on level surface.
2. Turn key switch OFF.
3. Move forward/reverse pedals to NEUTRAL position. Lock parking brake.
4. Raise hood.

CAUTION: Avoid Injury! Engine components are HOT. Be careful not to touch, especially the exhaust pipe or muffler while making adjustments. Wear protective eye glasses and clothing.

5. Remove spark plug.

IMPORTANT: Avoid damage! Do not clean spark plug with sand paper or abrasives. Engine scoring can result.

6. Scrape or wire brush deposits from spark plug.
7. Inspect spark plug for:
   - Cracked porcelain
   - Pitted or damaged electrodes



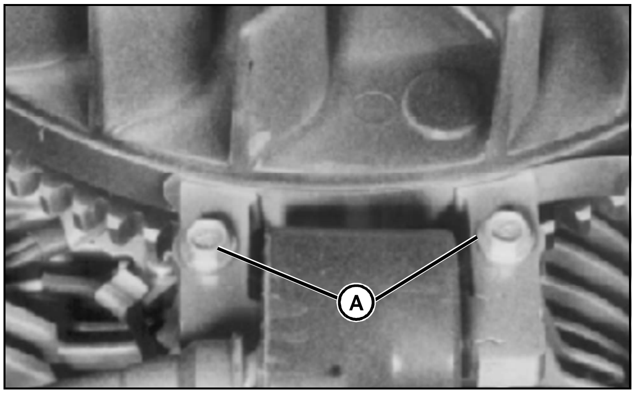
M48365

8. Check spark plug gap using a feeler or wire gauge.
9. Install and tighten spark plug to specification.

Specifications:

Spark Plug Gap (FH500V) . . . . .1.0 mm (0.040 in.)
Spark Plug Gap (FH580V, SN 090001-) . 0.75 mm (0.030 in.)
Spark Plug Torque (FH500V) . . . . . . 15 N•m (130 lb-in.)
Spark Plug Torque (FH580V). . . . . . . 22 N•m (195 lb-in.)

Ignition Coil Air Gap Adjustment



M458969

1. Center flywheel magnet under armature.
2. Insert a feeler gauge between flywheel and armature.
3. Push armature against flywheel and tighten cap screws (A) to specification.
4. Turn flywheel to remove feeler gauge.

Specifications:

Ignition Coil Air Gap (LX277 - FH500V) . . . . 0.25 - 0.40 mm (0.010 - 0.016 in.)

Ignition Coil Air Gap (LX288 - FH580V, SN 090001-) . . . . . 0.30 mm (0.012 in.)

Ignition Coil Cap Screws . . . . 7.8 N•m (69 lb-in.)

Repair

Throttle Control Lever and Cable

Removal and Installation:

1. Remove dash panel.
2. Disconnect throttle control cable at engine. Remove throttle control cable assembly.
3. Replace throttle control lever or cable as required.

Installation is done in the reverse order of removal.

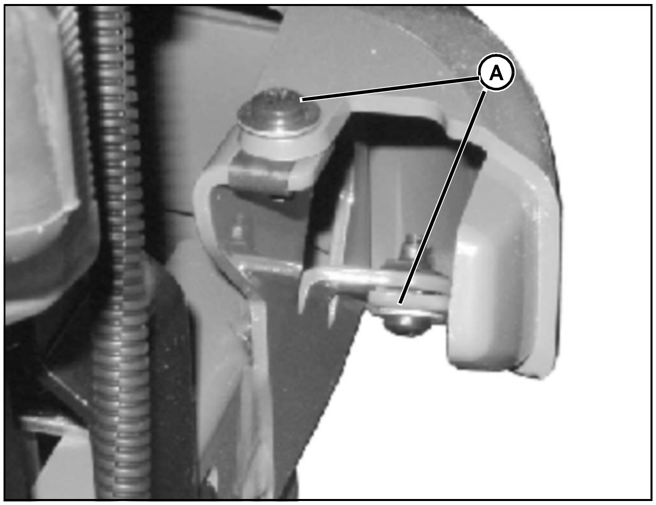
- Adjust throttle control cable and choke plate. See “Throttle Cable Adjustment” on page 82 and “Choke Plate Check and Adjustment” on page 83.

Muffler Removal and Installation

Removal:

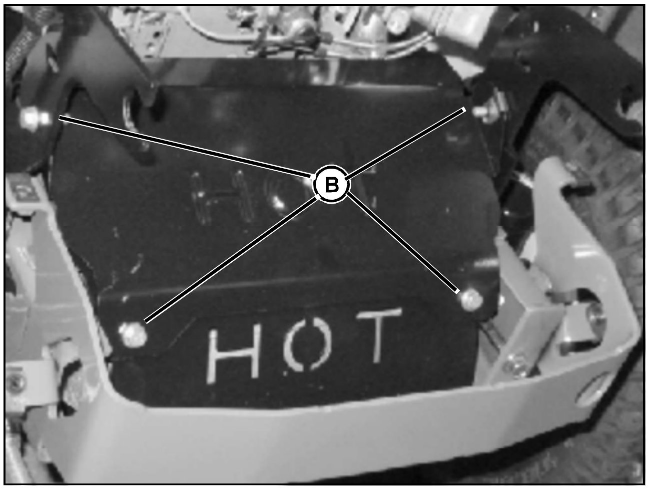
1. Remove engine hood. See “Hood Removal and Installation” on page 589 in the Miscellaneous section.

CAUTION: Avoid Injury! To prevent possible burns, allow engine to cool before removing muffler.



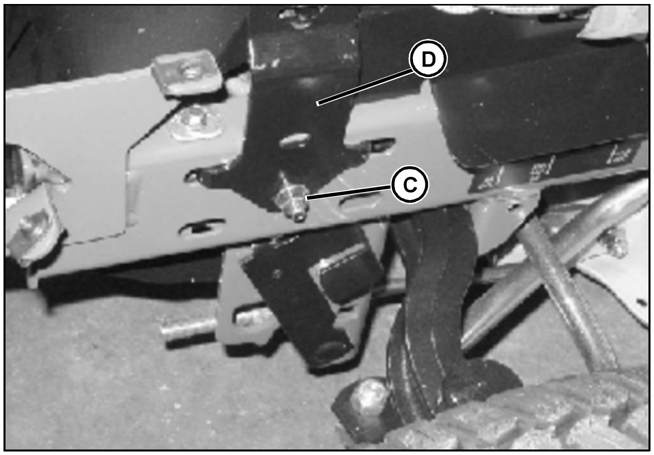
MX16320

2. Remove two retaining screws (A) on each side of bumper and remove bumper.



MX16323

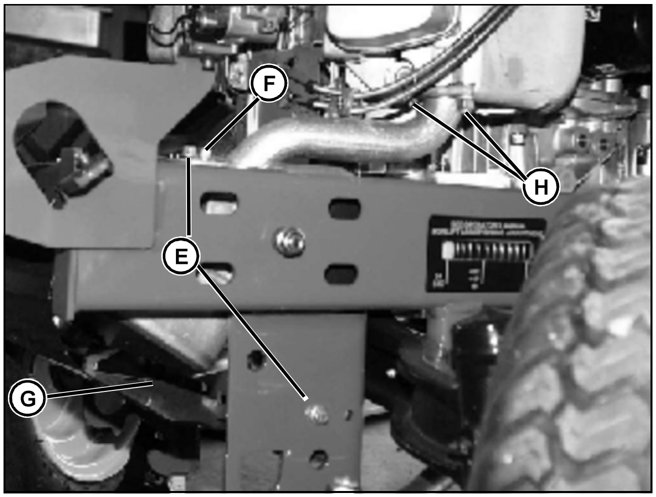
3. Remove four cap screws (B) from top heat shield.



MX16321

4. Remove nut (C) on each hood support bracket (D) and remove hood brackets.

5. Remove top heat shield.



MX16329

6. Remove lower heat shield cap screws (E) and remove lower heat shield (G).

7. Remove two muffler mounting bolts (F) and nuts and washers (H) from each side of engine.

8. Remove muffler.

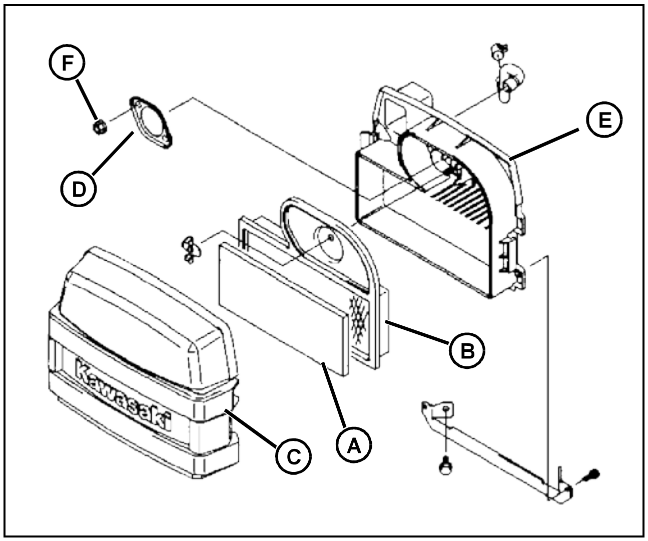
Installation is done in the reverse order of removal.

- Use new gaskets for installation.

Air Cleaner Assembly Removal

IMPORTANT: Avoid damage! Any time the air cleaner is removed, check for free choke operation during reassembly.

1. Remove and disassemble air cleaner.



M95367

2. Wash foam element (A) in detergent and water. Dry element.

3. Apply 12 - 15 drops of clean engine oil to foam element (A). Wrap element with a clean rag and squeeze out excess oil.

IMPORTANT: Avoid damage! Do not clean paper element with solvent or compressed air.

4. Gently tap paper element (B) to remove dust.

5. Inspect element.

   - Element is still usable if you can see light through it and element appears clean.
   - Replace if oily, dirty, or damaged in any way.

6. Inspect cover (C), gasket (D), and base (E) for damage. Replace parts as necessary.

7. Assemble and install air cleaner.

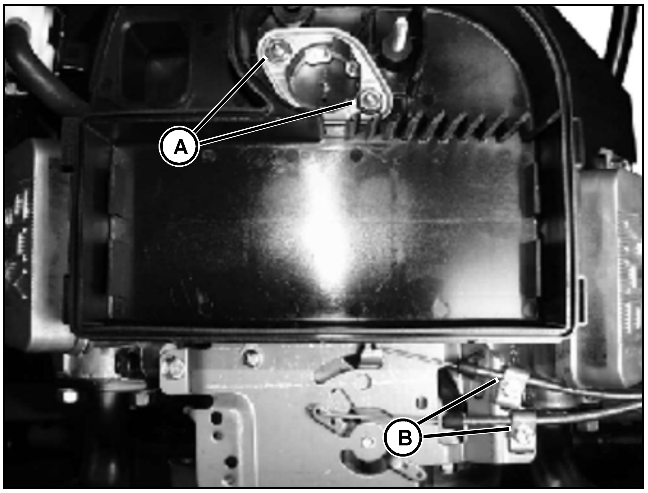
8. Tighten locknuts (F) to 6.9 N•m (61 lb-in.).

Carburetor Removal and Installation

Removal:

CAUTION: Avoid injury! Gasoline is extremely flammable. Do not smoke. Always work in a ventilated area away from open flame or spark producing equipment, including equipment that utilizes pilot lights

1. Unsnap and remove air cleaner cover and air filter.

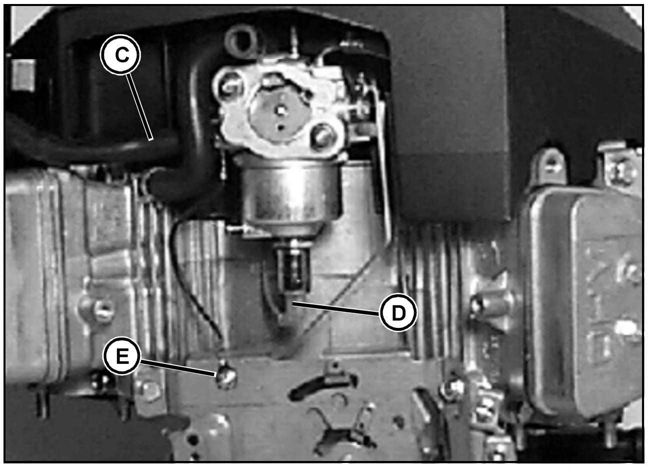


M99557

2. Loosen the clamps (B) securing the throttle and choke cables. Remove the cable ends from the engine.

3. Remove the two screws and two nuts (A) that hold the air cleaner base to the carburetor.

4. Carefully pull air cleaner base away from carburetor and remove crankcase vent tube from back of air cleaner base.

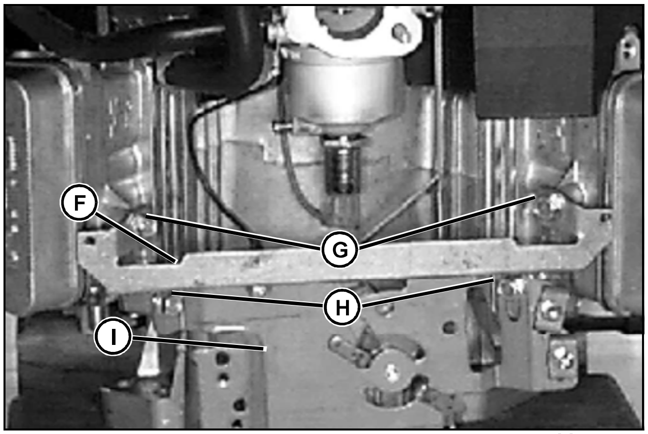


M95376

5. Remove and plug the fuel inlet hose (C).

6. Drain fuel from carburetor.

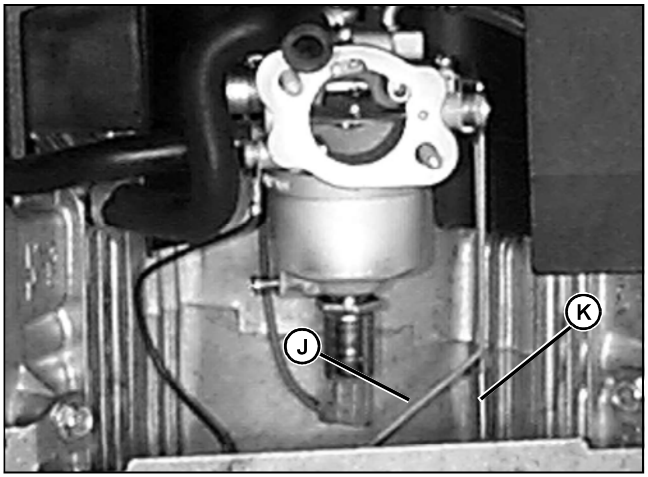
7. Disconnect wire connector (D) to the fuel shutoff solenoid and wire connector (E) grounding the fuel shutoff solenoid.



M95379

8. Remove two capscrew (G) holding the air cleaner mounting bracket (F) in place, and the two capscrews (H) holding the control panel (I) in place.

9. Carefully pull the control panel away from engine and disconnect the governor spring and choke rod from the control panel.



M95379

10.While pulling the carburetor forward disconnect the choke rod (J) and then the throttle link and throttle spring (K) from the carburetor.

Installation is done in the reverse order of removal.

- Tighten fasteners to specification.

Specifications:

Ground Screw (LX277 - FH500V)	**3.4 N•m (30 lb-in.)**
Air Cleaner Mounting Plate	**6.9 N•m (61 lb-in.)**
Control Panel Mounting Screws	**6.9 N•m (61 lb-in.)**
Air Cleaner Base Nuts	**6.9 N•m (61 lb-in.)**
Air Cleaner Base Screws	**3.9 N•m (35 lb-in.)**

Carburetor Disassembly and Assembly

Disassembly:

> **CAUTION: Avoid Injury! Gasoline is extremely flammable. Do not smoke. Always work in a ventilated area away from open flame or spark producing equipment, this includes equipment that utilizes pilot lights.**

1. Refer to “Carburetor Components (LX277 - FH500V)” on page 78 or “Carburetor Components (LX288 - FH580V)” on page 79 for illustrations showing component location.
2. There are several passage plug balls in carburetor body. DO NOT remove these plugs.
3. When removing the pilot air screw (B), carefully mark the position of the air screw limiter on the carburetor body so that it can be installed and set to its original position later.
4. Remove limiter. Be careful not to turn pilot air screw at this point.
5. Turn the pilot air screw clockwise and count the number of turns until screw is gently seated in the pilot passage.
6. Record the number of turns needed to close the pilot air screw.
7. Turn out the pilot air screw and replace with a new one.

> **IMPORTANT: Avoid damage! To remove float, use a long nosed pliers on end of pin. Do not strike opposite end of pin. Damage to pin holder may result.**

Clean/Inspect/Rebuild:

> **IMPORTANT: Avoid damage! Do not clean holes or passages with small drill bits or wire.**

NOTE: If all rubber and plastic parts cannot be removed for cleaning, use a cleaning solvent with a high flash point that will not damage these parts when cleaning.

1. Remove rubber and plastic parts from carburetor. Soak all carburetor metal parts in carburetor cleaning solvent for 1/2 hour maximum.

> **IMPORTANT: Avoid damage! Rinse carburetor body in warm water to neutralize corrosive action of cleaner on aluminum.**

2. Spray all passages with a carburetor cleaning spray to verify that all internal passages are open.

> **CAUTION: Avoid injury! Reduce compressed air to less than 210 kPa (30 psi) when using for cleaning purposes. Clear area of bystanders, guard against flying chips, and wear personal protection equipment including eye protection.**

3. Rinse carburetor with warm water and dry with compressed air. Do not use rags or paper to dry parts; lint may plug holes or passages.
4. Inspect all parts for wear or damage, replace as necessary.

NOTE: Main jet high altitude kits are available.

Assembly:

1. Install new pilot air screw until screw is gently seated.
2. Open the screw the same number of turns as recorded prior to removal.
3. Align the limiter with the mark on the carburetor body to install, taking care not to turn the pilot air screw.
4. Install the throttle valve on the shaft with numerical mark on the valve facing to the outside.
5. Note the metering hole in the choke valve. Install the choke valve on the shaft so that the metering hole is towards outside of the carburetor.
6. Install the float pin so that it’s big diameter side faces the engine flange side. Float is plastic. The float cannot be adjusted. Replace if necessary.
7. Tighten all fasteners to specification listed.

Specifications:

Choke Valve Screw	**0.7 N•m (6 lb-in.)**
Throttle Valve Screws (FH500V)	**1.0 N•m (9 lb-in.)**
Throttle Valve Screws (FH580V)	**0.7 N•m (6 lb-in.)**
Pilot Jet	**1.7 N•m (15 lb-in.)**
Main Jet (FH500V)	**0.7 N•m (6 lb-in.)**
Main Jet (FH580V)	**2.3 N•m (20 lb-in.)**
Main Air Jet	**0.7 N•m (6 lb-in.)**
Main Nozzle	**2.0 N•m (17 lb-in.)**
Pilot Air Jet	**0.7 N•m (6 in-lb.)**
Drain Screw (Carburetor)	**1.3 N•m (11 lb-in.)**
Earth Lead Screw (Carburetor Side)	**3.4 N•m (30 lb-in.)**
Fuel Shutoff Solenoid Valve (Carburetor)	**6.9 N•m (61 lb-in.)**
Float Chamber Mounting Screw (FH500V)	**8.8 N•m (78 lb-in.)**
Float Chamber Mounting Screw (FH580V)	**8.8 N•m (40 lb-in.)**

Governor Shaft Plate Screws . . . . . . 2.0 N•m (18 lb-in.)

Holder Plate Nuts (Air Cleaner, Carburetor Mounting) . 5.9 N•m (52 lb-in.)

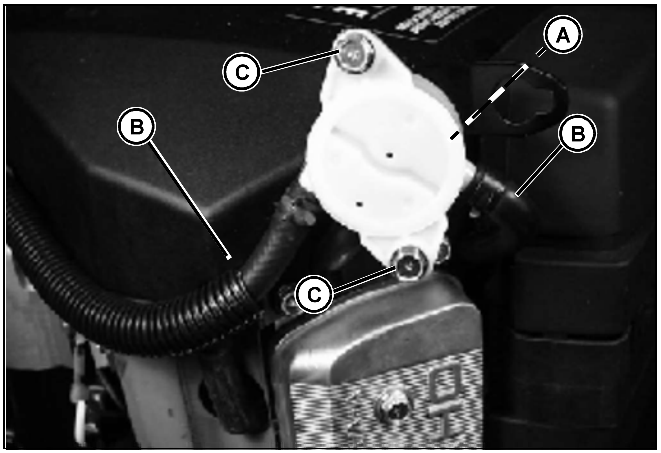
Air Cleaner Body Mounting Screws . . . . 3.4 N•m (30 lb-in.)

Fuel Pump Replacement

Removal:

1. Park machine on level surface.
2. Turn key switch OFF.
3. Move forward/reverse pedals to NEUTRAL position. Lock parking brake.
4. Raise hood.

CAUTION: Avoid Injury! Gasoline is extremely flammable. Do not smoke. Always work in a ventilated area away from open flame or spark producing equipment, this includes equipment that utilizes pilot lights.



M99564

5. Disconnect vacuum line (A) (hidden from view) and fuel lines (B).
6. Remove two mounting screws (C).

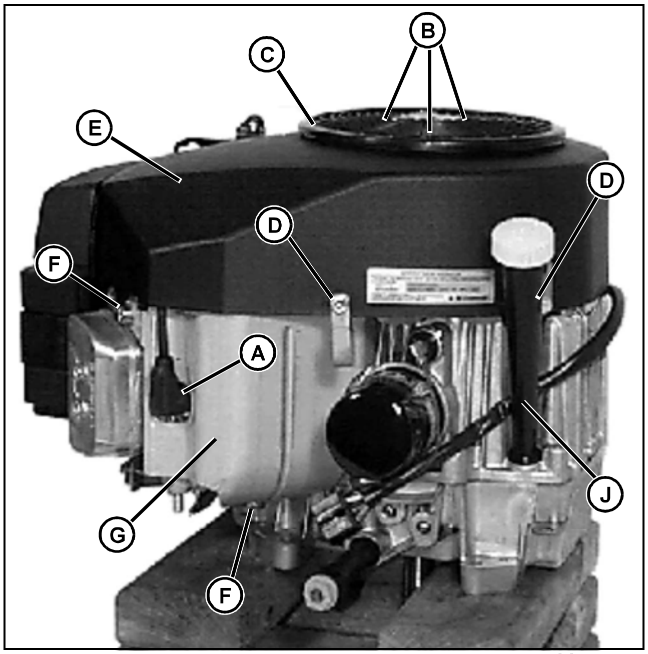
Installation:

Installation is done in the reverse order of removal.

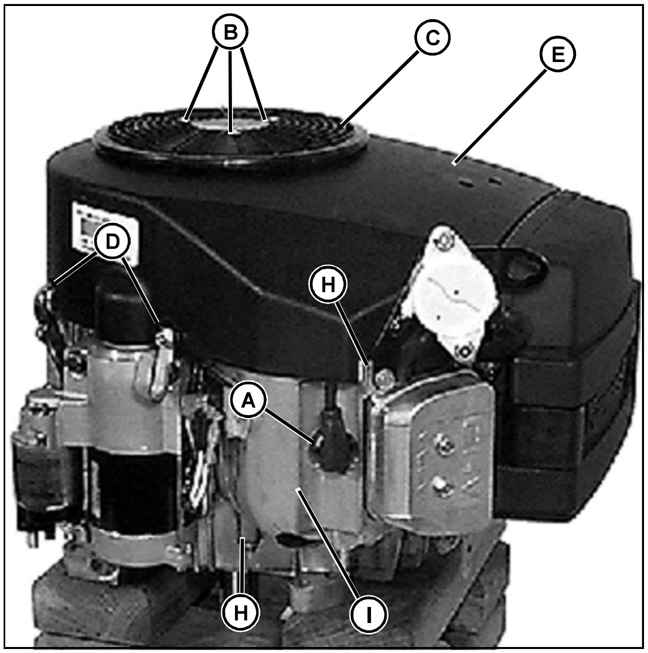
- Replace fuel pump.
- Tighten mounting screws to 16 N•m (142 lb-in.).

Blower Housing Removal and Installation

Removal:



M95399



M95400

1. Disconnect spark plug caps (A).
2. Remove three screws (B) securing the flywheel screen (C) to the flywheel. Remove flywheel screen.
3. Remove four screws (D) (two on each side) securing the upper blower housing (E) to the block and lower housings. Remove upper blower housing.
4. Remove two screws (F) (upper photo) and remove left side lower blower housing (G).

5. Remove two screws (H) (lower photo) and remove left side lower blower housing (I).

6. Remove dipstick tube (J).

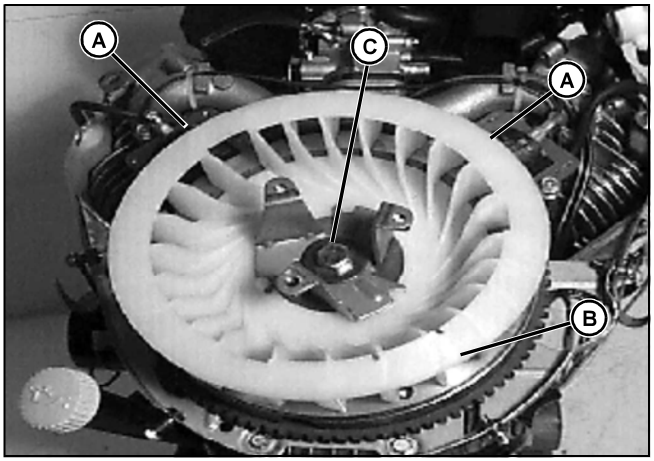
Installation:

Installation is done in the reverse order of removal.

Flywheel Removal and Installation

Removal:

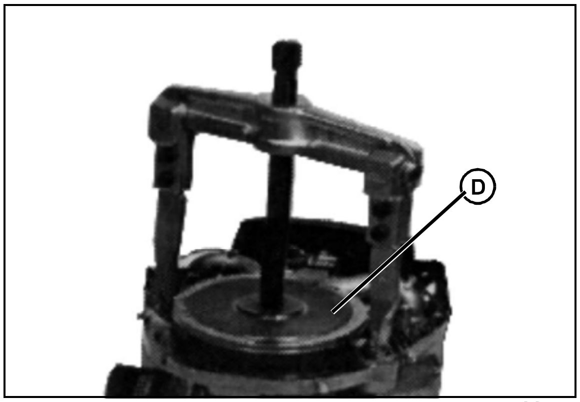
1. Remove blower housing. See “Blower Housing Removal and Installation” on page 96.



M95382

2. Remove both armature coils (A).

3. Hold flywheel (B) and remove cap screw (C).



M95381

4. Remove flywheel (D) using a flywheel puller.

Installation:

- Tighten nut to specification.
- Adjust armature air gap. See “Ignition Coil Air Gap Adjustment” on page 92.

Specification:

Flywheel Nut Torque . . . . 56 N•m (41 lb-ft)

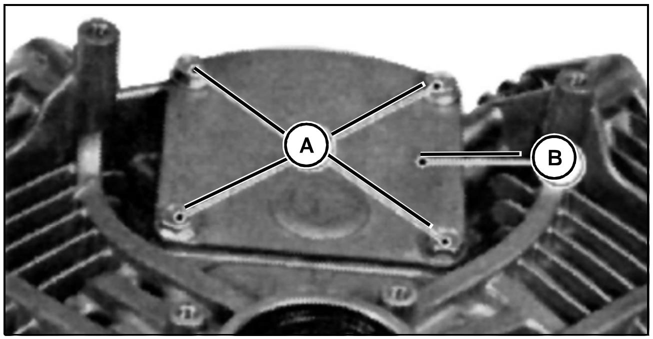
Breather Removal and Installation

Procedure:

1. Remove screen and blower housing.

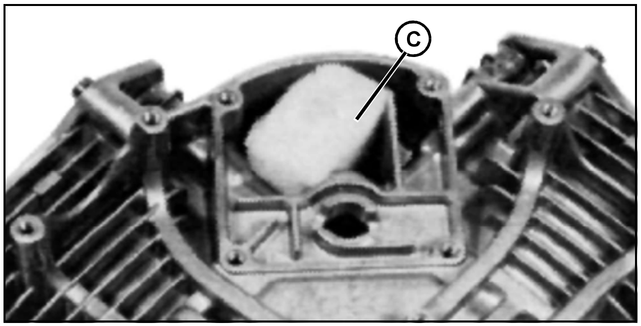
2. Remove fan and flywheel.

3. Remove carburetor and intake manifold.



M95368

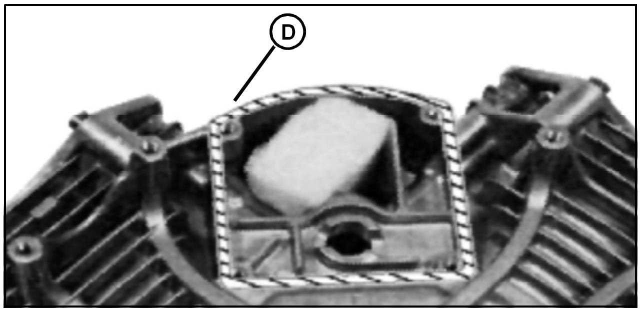
4. Remove four screws (A) securing the breather chamber cover (B) to the crankcase.



M95369

5. Remove and replace breather element (C), or clean with solvent and allow to dry.

6. Check drain hole on breather chamber make sure no foreign material has accumulated.



M95370

7. Apply sealant to the mating surface of the crankcase and install a new gasket (D).

8. Install the breather chamber cover and tighten four capscrews to specification.

9. Install flywheel. See “Flywheel Removal and Installation” on page 97.

Specifications:

Breather Cover Cap Screws	**6.9 N•m (61 lb-in.)**
Flywheel Nut Torque	**56 N•m (41 lb-ft)**

Engine Removal and Installation

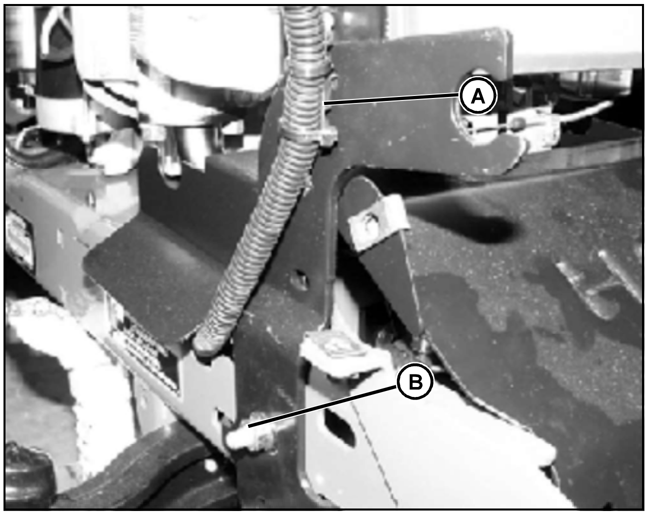
Removal:

1. Park machine on a flat surface. Turn engine OFF, and lock parking brake.

2. Remove mower deck.

3. Raise and remove hood. See "Hood Removal and Installation" on page 589 in the Miscellaneous section.

4. Disconnect negative (-) battery cable at battery. Disconnect positive (+) battery cable at battery.

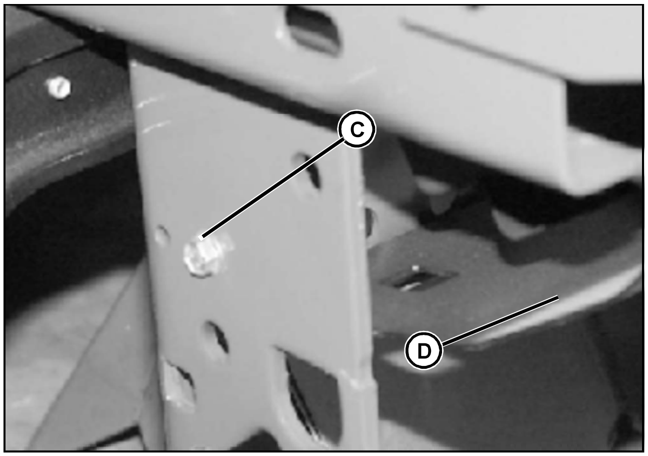


M99525

5. Remove headlight wiring harness clip (A) from frame.

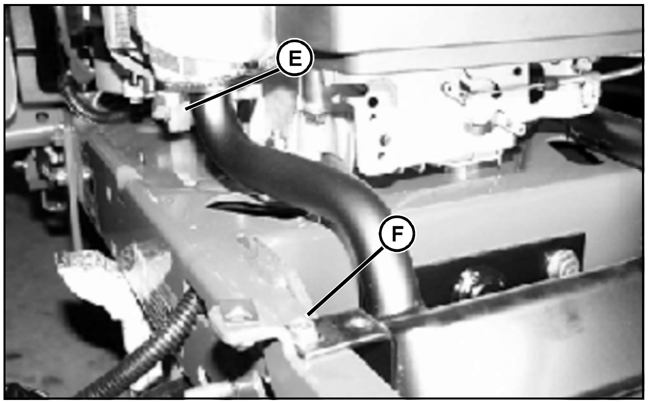
6. Remove two flange nuts (B) securing hood support brackets. Remove brackets.

7. Remove four cap screws and upper heat shield.



M95524

8. Remove four cap screws (C) and lower heat shield (D).

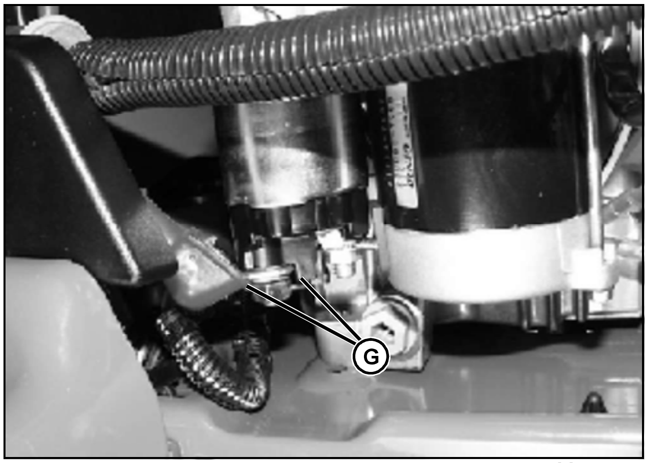


M99526

9. Remove lock washers and nuts (E) securing the muffler exhaust tubes to the cylinder heads.

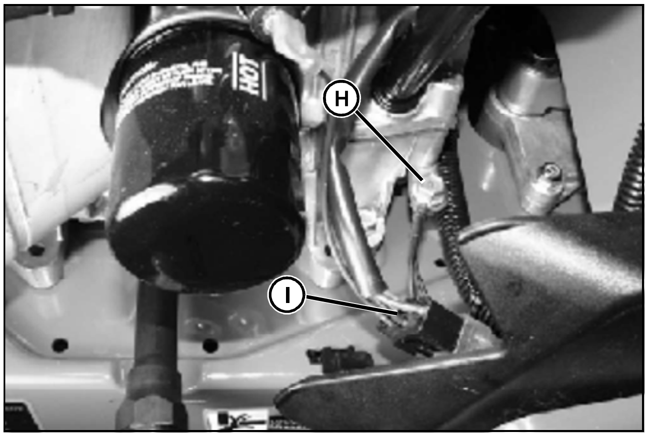
10.Remove cap screws (F) and muffler and muffler gaskets.

11.Remove starting motor lug nut and remove cables from starting motor.



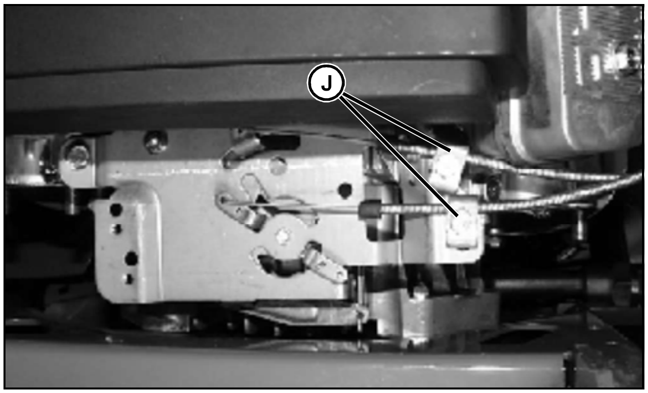
M99553

12.Remove spade connectors (G) from starting motor solenoid.



M99554

13.Disconnect engine wiring harness connector (I) from the main wiring harness, and ground wire (H) from engine.



M99555

14.Loosen cap screws securing throttle and choke cable clamps (J). Remove cable ends from engine.

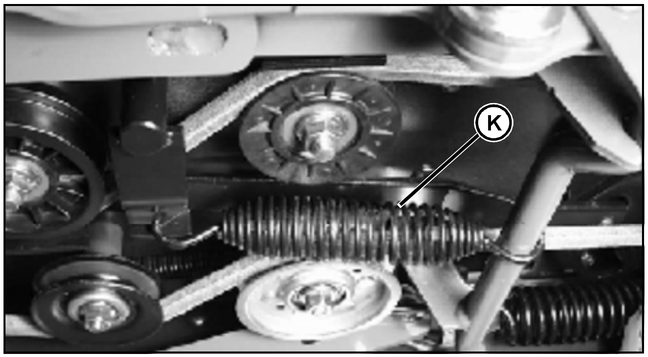
CAUTION: Avoid Injury! Gasoline is extremely flammable. DO NOT SMOKE. Always work in a well ventilated area away from open flame or spark producing equipment; this includes equipment that utilizes pilot lights.

15.Disconnect fuel line at fuel pump. Plug fuel line end.

16.Drain engine oil. Capacity with filter is approximately 1.7 L (1.8 qt).

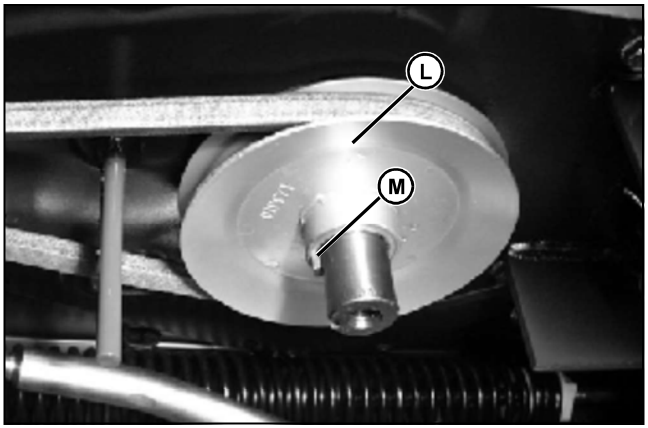
17.Remove electric PTO clutch. See “Electric Clutch Removal and Installation” on page 347 in the Electrical section.

CAUTION: Avoid injury! The drive belt is undr high tension when installed. Do not remove spring without wearing face and hand protection.



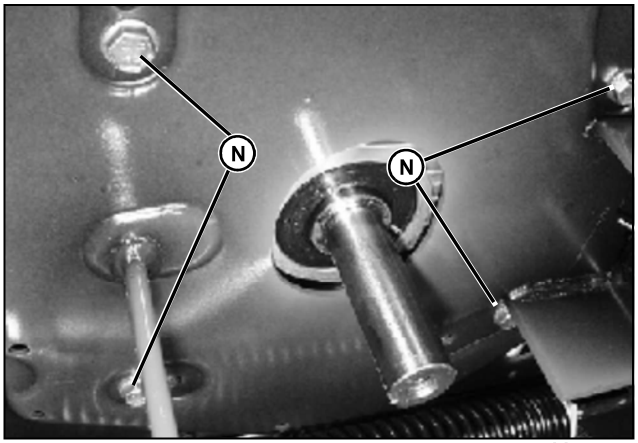
M99548

18. Disconnect drive belt tension spring (K).



M99549

19.Remove drive pulley (L) and key (M) from crankshaft.



M99550

20.Remove four cap screws (N) and locknuts securing engine to frame.

21.Remove engine from machine.

Installation:

Installation is done in the reverse order of removal.

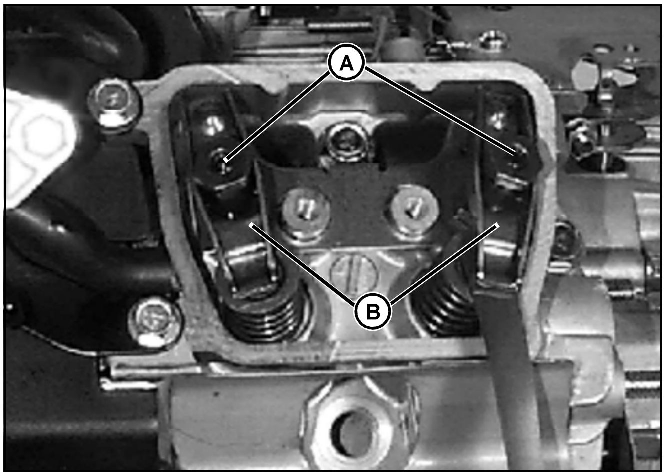
- Tighten engine mounting cap screws to 34 N•m (25 lb-ft).
- Install drive pulley, drive belt, and tension spring.
- Install electric clutch. See “Electric Clutch Removal and Installation” on page 347 in the Electrical section.
- Install lower and upper heat shields.
- Connect fuel line.
- Connect throttle and choke cables to engine.
- Connect engine wiring harness spade and lug connectors to starting motor.
- Fill engine with oil if oil filter was removed.
- Connect battery positive (+) cable and then battery negative (-) cable.
- Install left and right engine closeout panels (if removed).

- Adjust throttle and choke cables. See “Throttle Cable Adjustment” on page 82 and “Choke Cable Adjustment” on page 83.
- Install engine hood.

Rocker Arm Removal and Installation

Removal:

1. Remove rocker arm cover.
2. Turn crankshaft until piston is at TDC of compression stroke for the cylinder being worked on.



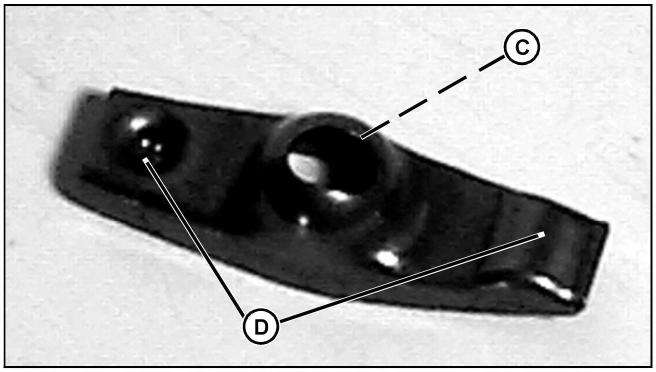
M95401

3. Remove valve clearance adjustment nut (A) and rocker arms (B).

IMPORTANT: Avoid damage! Mark push rods for reassembly in original locations

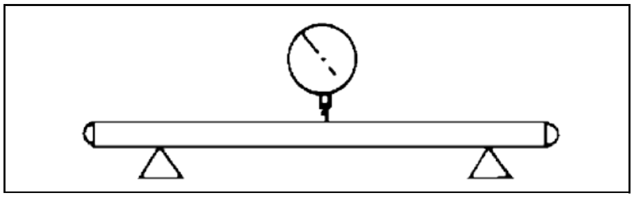
4. Inspect all parts for wear or damage. (See Inspection procedure.)

Inspection:



M95394

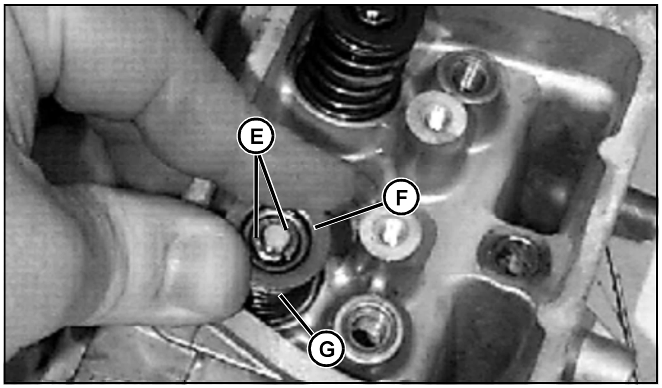
- Clean and inspect the rocker arm where it contacts the push rod and valve stem (D). Check the inside of the rocker arm where it pivots on the special nut (C). If the contact points are worn or damaged, replace the rocker arm.



M50044

- Inspect push rod for bend using V-blocks and a dial indicator. Turn rod slowly and read variation on indicator. Replace if variation is greater than 0.5 mm (0.020 in.).

Disassembly and Assembly:



M95402

1. Compress valve spring and remove collet halves (E).
2. Remove spring retainer (F) and spring (G).

Installation:

Installation is done in the reverse order of removal.

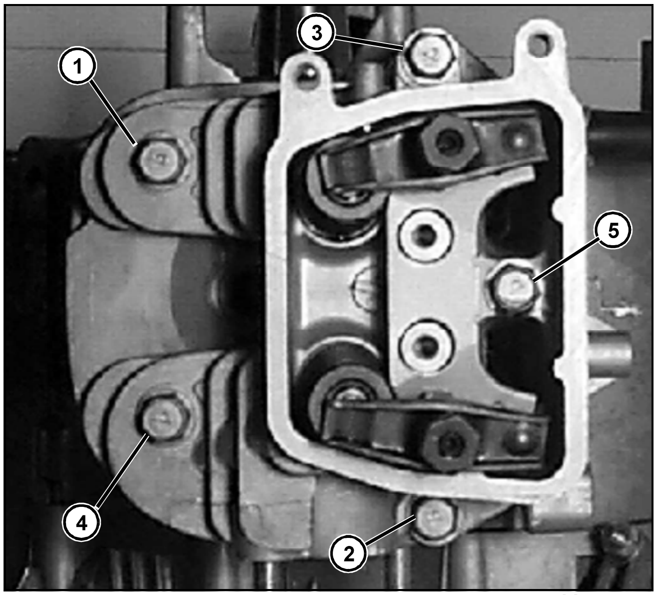
IMPORTANT: Avoid damage! Align rocker arms over push rods during assembly

- Check and adjust valve clearance. See “Valve Clearance Check and Adjustment” on page 86.
- Install rocker covers. Tighten rocker cover cap screws to 6.9 N•m (61 lb-in.).

Cylinder Head Removal and Installation

Removal:

1. Remove the following using procedures in this section:
   - Upper blower housing
   - Air cleaner and carburetor assemblies.
   - Muffler
   - Intake manifold
   - Spark plug



M95385

2. Remove rocker cover and gasket.

3. Turn crankshaft until piston is at TDC of compression stroke for the cylinder being worked on.

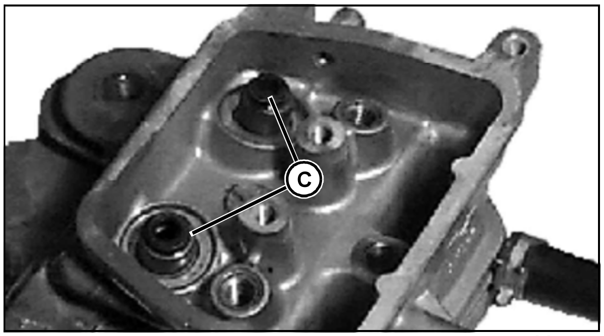
4. Loosen the cylinder head bolts 1/4 turn at a time, in sequence (above) to prevent warping the cylinder head during removal.

5. Remove cylinder head assembly.

6. Mark push rods for installation in their original position during assembly.

7. Remove rocker arms. See "Rocker Arm Removal and Installation" on page 100.

8. Disassemble, clean and inspect cylinder head and valves.



M95403

9. If necessary to replace stem seal, carefully pry up from bottom (C) with a screwdriver.

10.Inspect springs, valves, guides, and seals for wear or damage. Replace as necessary. See "Cylinder Head Inspection" on page 101.

Installation:

IMPORTANT: Avoid damage! Gasket surfaces are coated with sealant. Do not damage surfaces or gasket during installation.

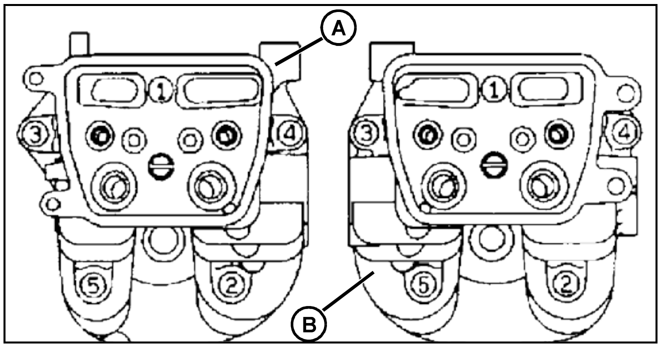
1. Set cylinder to TDC of compression stroke for the cylinder being worked on.

2. Set the cylinder head with gasket onto crankcase.

3. Slide the push rods into the crankcase by sliding the end of the rods down along the inside wall of the crankcase.

4. Position the push rod end on the tappet.

5. Align the upper push rod end under the rocker arms.



M95386

6. Torque should be applied in the sequence shown, in 7 N•m (62 lb-in.) increments for the number one (A) and number two (B) cylinders.

Torque Specifications:

First torque	**7 N•m (62 lb-in.)**
Second torque	**14 N•m (124 lb-in.)**
Third torque	**21 N•m (186 lb-in.)**
Final torque.	**25 N•m (221 lb-in.)**

7. Install the rocker arms. See "Rocker Arm Removal and Installation" on page 100.

8. Check and adjust valve clearance. See "Valve Clearance Check and Adjustment" on page 86.

9. Install rocker covers. Tighten rocker cover cap screws to 5.9 N•m (52 lb-in.).

Cylinder Head Inspection

Procedure:

1. Remove cylinder heads. See "Cylinder Head Removal and Installation" on page 100.

2. Remove carbon deposits from combustion chamber and gasket surface using SCOTCH-BRITE® abrasive pads or an equivalent.

CAUTION: Avoid Injury! Reduce compressed air to less than 210 kPa (30 psi) when using for cleaning purposes. Clear area of bystanders, guard against flying chips, and wear personal protection equipment including eye protection.

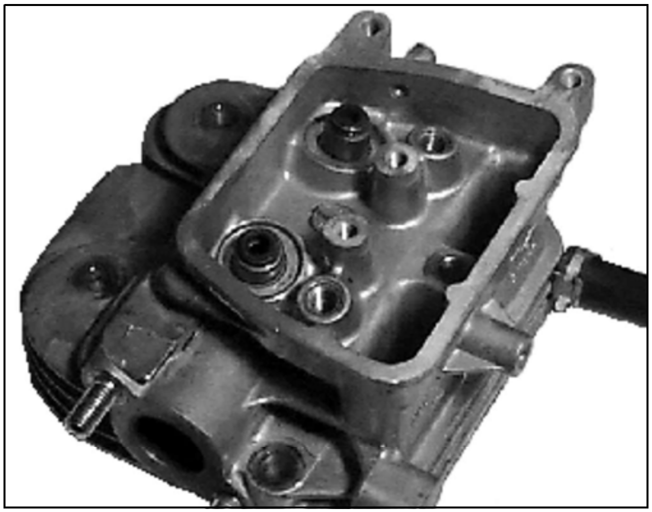
3. Clean head with a suitable solvent and dry with compressed air.

4. Inspect for cracks or broken cooling fins.

5. Inspect gasket surface for burrs and nicks.

6. Inspect head gasket for burns and traces of gas leakage. Replace if necessary.

7. Check that oil drainback passages are not plugged.

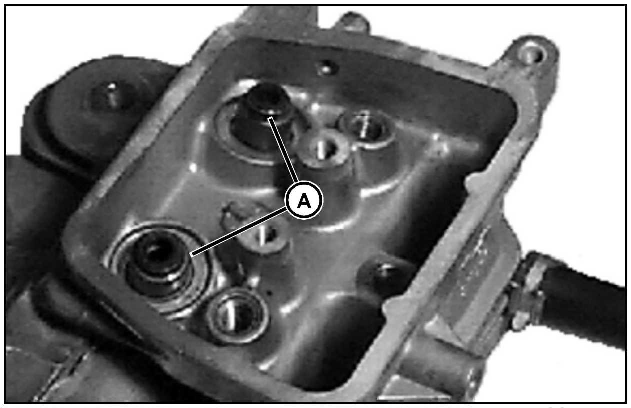


M95403

8. Put cylinder head on a surface plate. Check for distortion at several points around the head using a feeler gauge. Replace head if distortion is more than 0.05 mm (0.002 in.).

Valve Guides:

NOTE: Intake and exhaust valve guides cannot be replaced, replace head if worn.



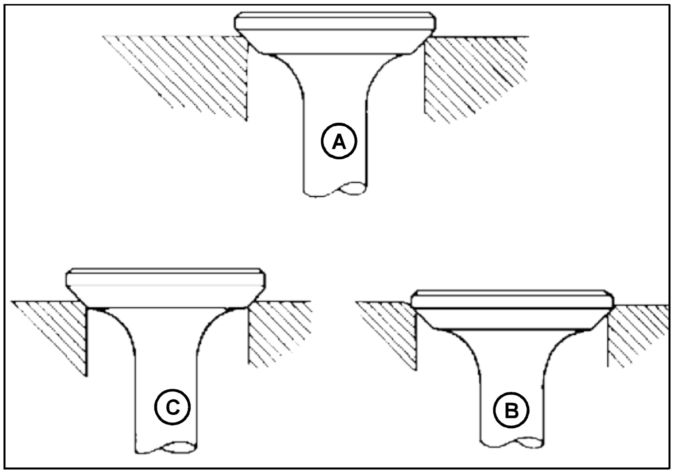
M95403

1. Clean inside of valve guides (A) with valve guide cleaner.

2. Measure inside diameter of valve guides in several places down the length of the guide. Replace cylinder head if inside diameter is greater than 6.08 mm (0.239 in.).

Valve Seats:

1. If valve seats are loose, warped or distorted beyond reconditioning, replace cylinder head. Pitted or worn seats can be re-faced using a seat cutter.



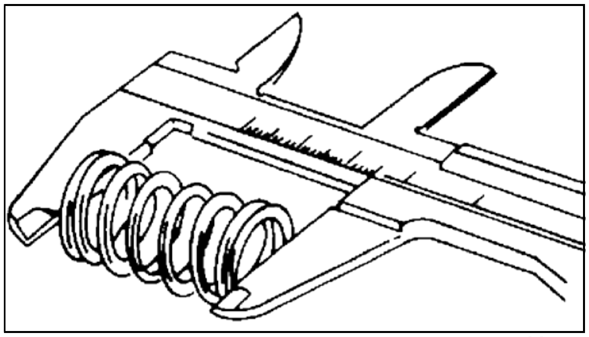
M18615

2. Check valve seating pattern for correct width and evenness all around (Note: correct seat position (A), seat too deep (B) and seat too high (C)). If valve seat width is not within 0.6 - 0.9 mm (0.024 - 0.035 in.) intake or 1.1 - 1.6 mm (0.04 - 0.06 in.) exhaust, recondition valve seat.

3. Lap valve after reconditioning with lapping compound and recheck valve seating surface for proper width and evenness of seating pattern. See “Lap Valves” on page 104.

Valve Springs:

1. Inspect spring for pitting, rust, and burrs. Replace if necessary.



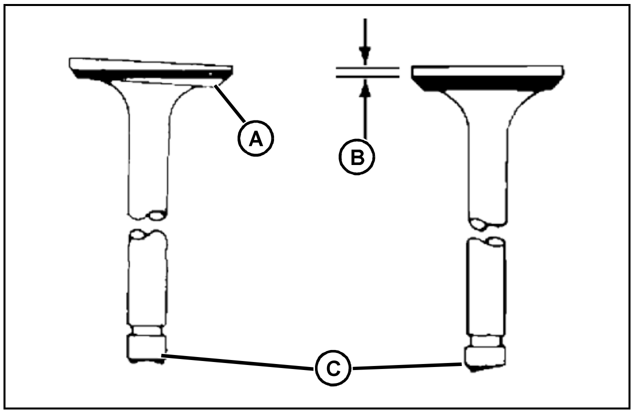
M50036

2. Measure spring free length. Replace spring if measurement is less than 31.0 mm (1.22 in.) for LX288 (FH580V) or 26.7 mm (1.05 in.) for LX277 (FH500V).

Intake and Exhaust Valves:

1. Remove carbon from valve head, face, and stem with a power-operated wire brush. Be sure carbon is removed, not merely burnished.

2. Inspect valve head, face, and stems for defects. Replace if necessary.



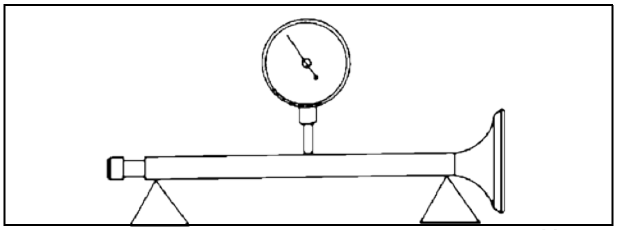
M38087

3. Replace warped valves (A) or valves with less than 0.35 mm (0.014 in.) margin (B).

4. Measure outside diameter of valve stem. Replace valve if diameter is less than specification.

Minimum Valve Stem OD Specifications:

Intake	**5.95 mm (0.234 in.)**
Exhaust	**5.93 mm (0.233 in.)**



M51753

5. Check valve stem for bend using V-blocks and a dial indicator. Turn valve slowly and read variation on indicator. Replace valve if variation is greater than 0.05 mm (0.002 in.).

IMPORTANT: Avoid damage! Do not grind the exhaust valve or life will be shortened.

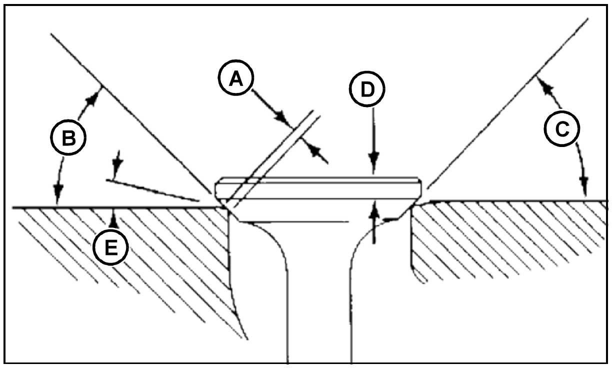
6. Grind the intake valve to 45°. Replace valve if margin is less than 0.35 mm (0.014 in.) after grinding.

Recondition Valve Seats

Procedure:

1. Inspect valve seats for damage. If seats are warped or distorted beyond reconditioning, replace cylinder head.

Pitted or worn seats can be refaced using a seat cutter.



M9552

2. To recondition seat, cut at 45° angle (B) to clean up seat. Cut narrowing angle (E) at 30°. Finish cut at 45° (B) to establish seating surface width (A).

3. Cut valve seating surface (A) as close as possible to specifications.

Specifications:

A - Valve Seating Surface	
(Standard) Intake	**0.6 - 0.9 mm (0.024 - 0.035 in.)**
(Standard) Exhaust	**1.1 - 1.6 mm (0.04 - 0.063 in.)**
B - Valve Seat Angle	**45°**
C - Valve Face Angle	**45°**
D - Valve Margin (Minimum)	**0.35 mm (0.014 in.)**
E - Valve Narrowing Angle	**30°**

4. Lap valves to seats after re-facing. See “Lap Valves” on page 104.

5. Center valve seat on the valve face.

6. Check seat for good contact using Prussian Blue Compound.

Lap Valves

Procedure:

NOTE: If valve seat does not make proper contact, lap the valve into the seat.

M50041

1. Apply a small amount of fine lapping compound to face of valve.

2. Grip top of valve with a vacuum cup tool and rotate valve to lap valve to seat.

3. Lift valve from seat every 8 to 10 strokes. Lap until a uniform ring appears around the surface of the valve face.

4. Wash all parts in solvent to remove lapping compound. Dry all parts.

5. Check position of lap mark on valve face. Lap mark must be on or near center of valve face.

Crankcase Cover Removal and Installation

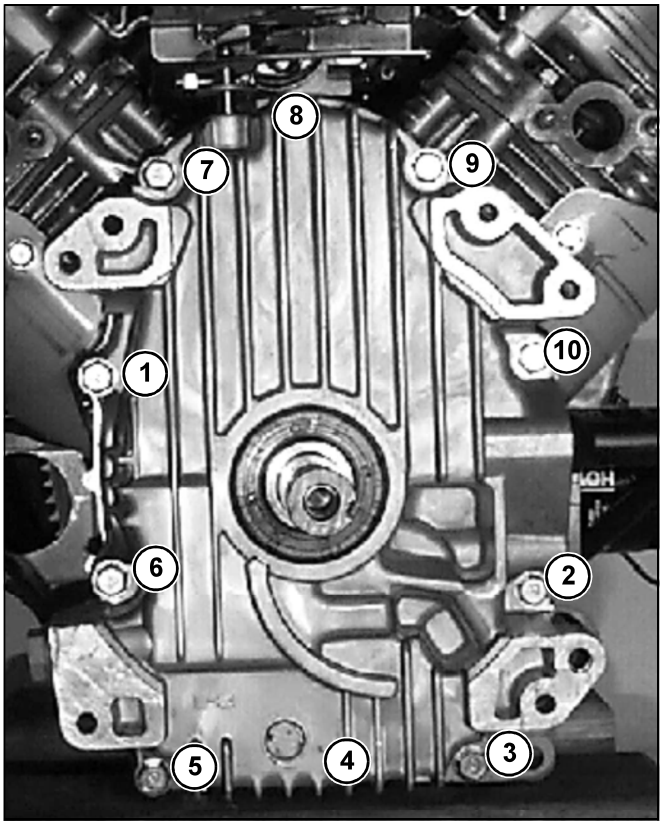
Removal and Installation:

1. Drain crankcase. Capacity (with filter) is approximately 1.7 L (1.8 U.S. qt).

2. Remove crankcase cover and gasket.

3. Clean crankcase and crankcase cover gasket surfaces.

NOTE: Do not force cover. Gears must mesh for proper positioning.



M95380

4. Install gasket and cover. Tighten cap screws in a two step process to specification. Use the sequence shown above.

Torque Specifications:

Initial torque . . . . 10 N•m (88 lb-in.)
Final torque. . . . . 25 N•m (221 lb-in.)

Piston and Connecting Rod

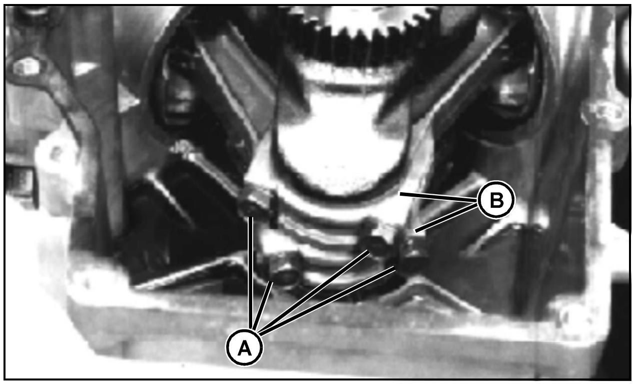
Removal:

1. Remove cylinder head.

2. Split the crankcase.

3. Remove the camshaft.

4. Turn the crankshaft to expose the connecting rod cap screws.



M51726

5. Remove the cap screws (A) and take off the connecting rod caps (B). Note the position of the connecting rod caps for reinstalling the caps.

6. Check cylinder bore for carbon and varnish ridges. These ridges can cause piston damage if not removed.

7. If necessary, remove ridges from top of cylinder bore with a ridge reamer.

8. Push piston and connecting rod into the cylinder and pull out of the cylinder bore.

Disassembly:

- Remove piston rings with a piston ring expander.
- Inspect all parts for wear or damage. Replace as necessary.

NOTE: Location of the arrow match mark on the piston head in relation to "K" mark on the connecting rod. Keep parts together as a set.

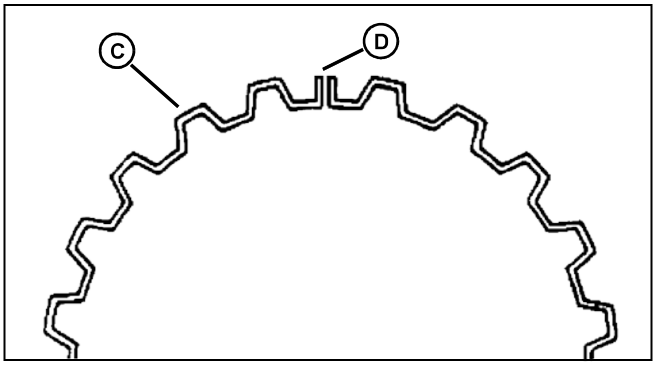
1. Remove one of the piston pin snap rings with a needle nose pliers.

2. Remove the piston pin by pushing it out of the side of the piston that has the ring removed.

3. Using a piston ring pliers, remove the top and second rings.

4. Remove the three piece oil ring.

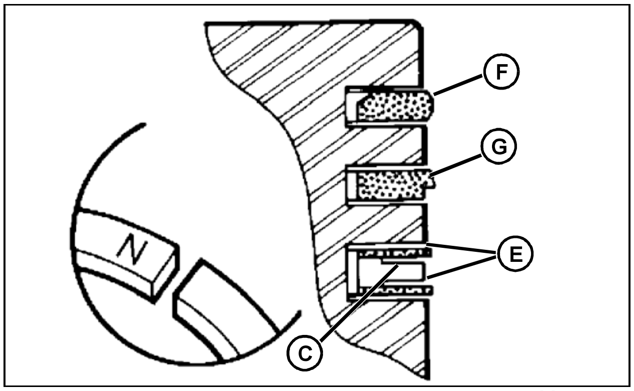
Assembly:



M95389

1. Install the expander (C) in the piston oil ring groove so that the expander ends (D) touch together. Be sure that they do not overlap.

2. Install the upper and lower steel oil rails. There is no up or down to the rails. They can be installed either way.



M38074c

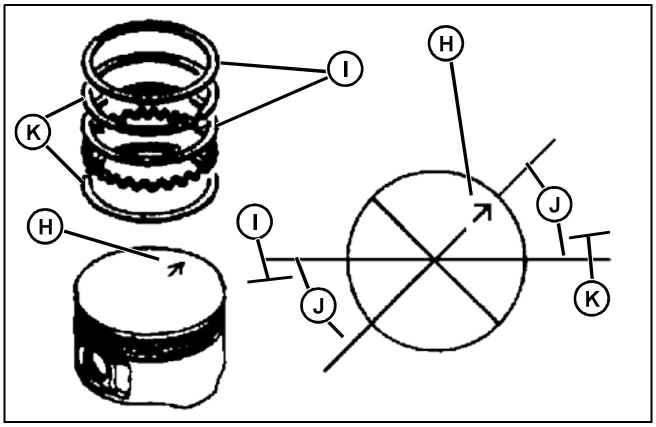
C - Expander

E - Steel Oil Rails

F - First Chrome - Plated Compression Ring

G - Second Compression Ring

Install the chrome-plated top ring and second ring with "N" mark facing up. The rings should turn freely in the grooves.



M95393

H - Arrow match mark

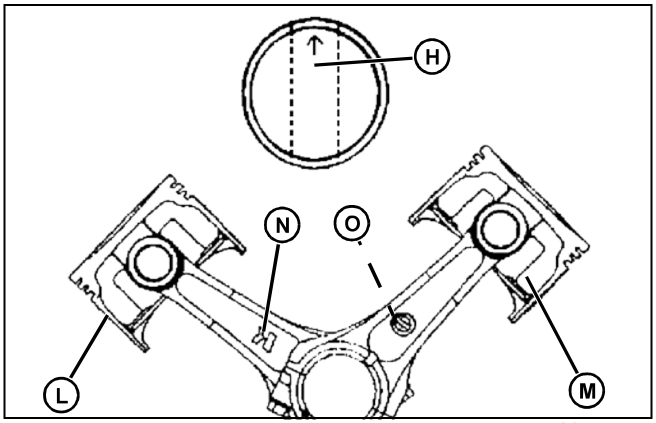
I - Top ring end gap, upper steel rail end gap

J - 30° - 45°

K - Second ring end gap, lower steel rail end gap

Align the piston and rings with the piston ring end gap as shown above.

3. Apply a light film of clean engine oil to piston pin and connecting rod bearing during assembly.



M95392

H - Arrow match mark

L - No. 1 Cylinder Piston

M - No. 2 Cylinder Piston

N - “K” Mark

O - “K” Mark on Opposite Side

No. 1 cylinder piston:
Align the arrow match mark on the piston head with opposite the raised letter “K” mark on the connecting rod.

4. No. 2 cylinder piston:
Align the arrow match mark on the piston head with the raised letter “K” mark on the connecting rod.

5. Install piston pin and snap ring. Compress snap ring only enough to install the snap ring.

6. Fit a new piston pin snap ring into the side of the piston so that the ring opening of the snap ring does not coincide with the notch in the edge of the piston pin hole.

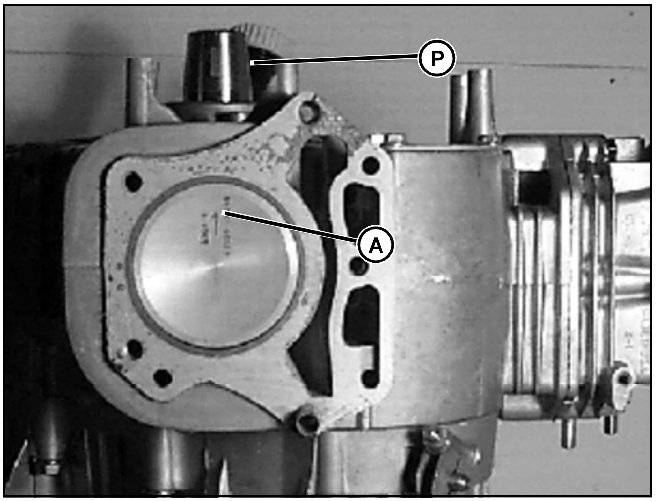
Installation:

1. Deglaze cylinder bore.

2. Apply a light film of oil to piston and rings. Compress rings with a ring compressor.

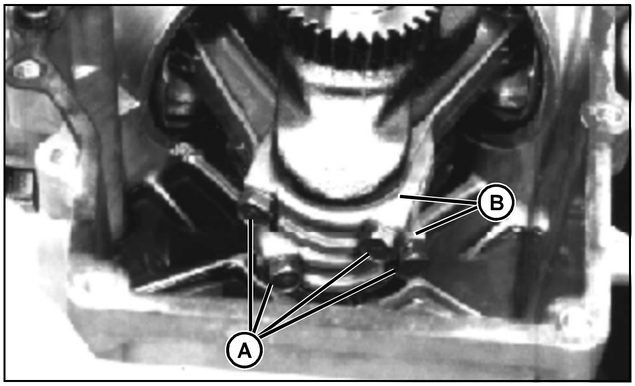
M50074

3. Apply a light film of oil to piston skirt, cylinder bore, connecting rod bearing surface and cap screws.



M95391

4. Install piston assembly in cylinder bore with engraved match mark/arrow (H) on piston head facing flywheel side (P) of engine.



M51726

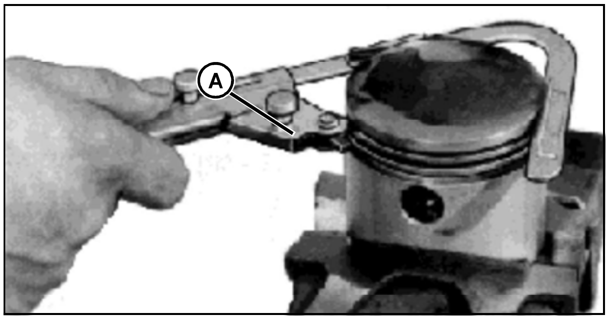
5. Install connecting rod cap (B) and cap screws (A). Tighten cap screws to 5.9 N•m (52 lb-in.) for LX277 and 9.8 N•m (87 lb-in.) for LX288.

6. Install crankcase cover and cylinder head.

Piston Inspection:

IMPORTANT: Avoid damage! Do not use a caustic cleaning solution or a wire brush to clean piston.

1. Remove all deposits from the piston.



M29946

2. Clean carbon from piston ring grooves with a ring groove cleaner (A). If cleaning tool is not available, break an old ring and use it to carefully clean groove.

3. Check that oil return passages in grooves are open.

4. Inspect piston for scoring or fractures. Replace piston if damaged.

NOTE: Inspect ring groove clearance visually. Replace piston if clearance appears excessive.

M38102

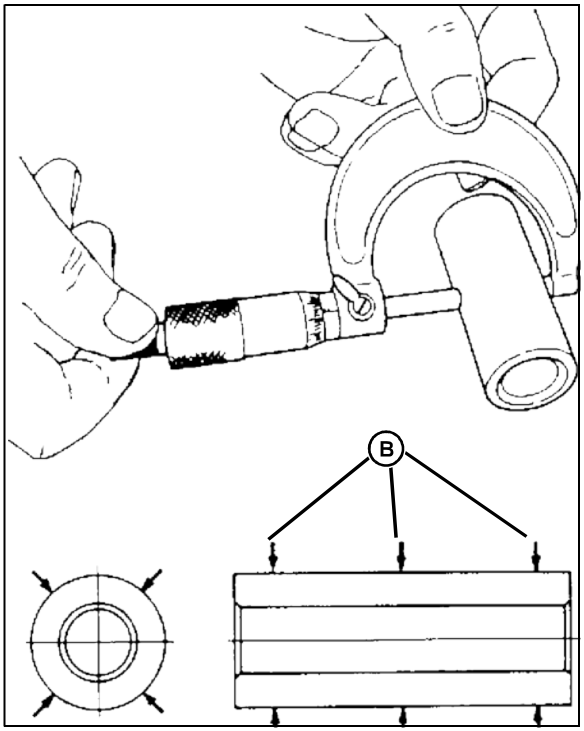
5. Check ring grooves for wear at several points around piston. Replace piston if clearance is greater than specifications.

Ring Groove Side Clearance Specifications:

1st Compression Ring (Top) . . . . . . 0.18 mm (0.007 in.)

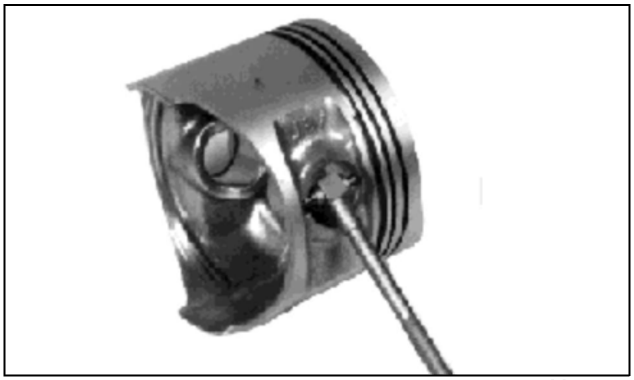
2nd Compression Ring (Middle) . . . 0.16 mm (0.006 in.)

6. The oil ring is a three piece assembled ring. It is difficult to measure the ring groove clearance and thickness, visually inspect only.



M82050A

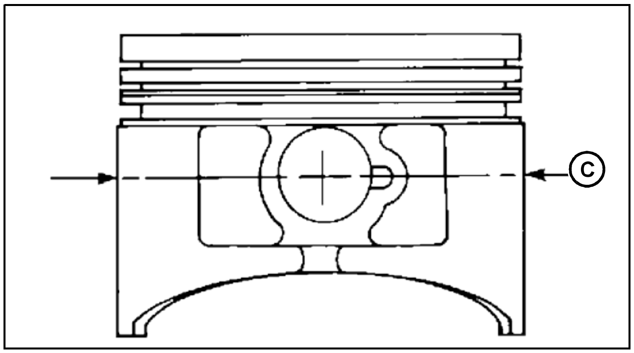
7. Measure piston pin diameter at six places (B). Replace pin if measurement is less than 15.96 mm (0.628 in.).



M80427

8. Measure piston pin bore. Replace piston if measurement is greater than 16.05 mm (0.632 in.).

NOTE: If the engine has had a previous major overhaul, oversize piston and rings may have been installed. Piston and rings are available in 0.50 mm (0.020 in.) oversize.



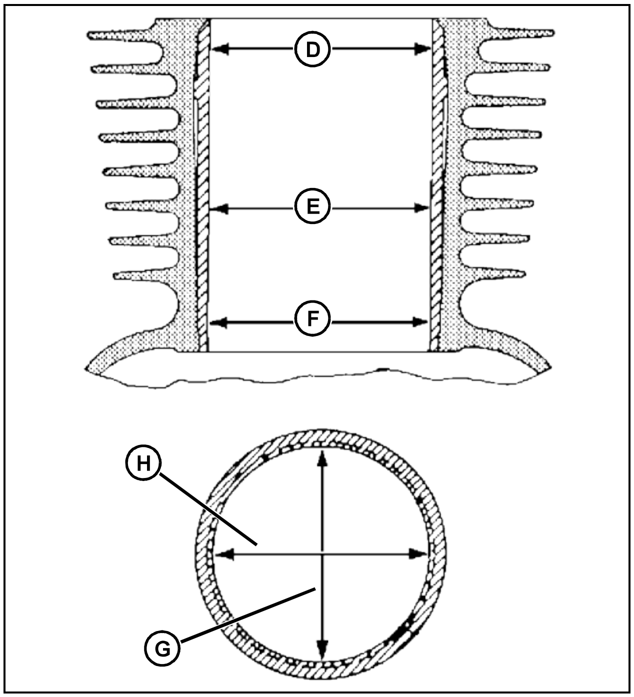
M80398

9. Measure piston OD (C) perpendicular to piston pin bore. If piston diameter is less than specifications, install a new piston.

Piston OD Specifications:

Standard Piston . . . . 73.79 mm (2.905 in.)

Oversized Piston . . . . 75.49 mm (2.970 in.)



M82411A

10.Measure cylinder bore diameter at three positions; top (D), middle (E) and bottom (F). At these three positions, measure, in both directions; along crankshaft centerline (G) and direction of crankshaft rotation (H).

NOTE: If the engine has had a previous major overhaul, oversize piston and rings may have been installed. Pistons and rings are available in 0.50 mm (0.020 in.) oversize.

Cylinder Bore ID:

Standard Size Bore (LX288 - FH580V):

Standard . . . . 73.98 - 74.00 mm (2.912 - 2.913 in.)

Standard Bore Size
(LX277 - FH500V) . . 67.98 - 68.00 mm (2.676 - 2.677 in.)

Wear Limit (LX288 - FH580V) . . . . 74.10 mm (2.917 in.)

Wear Limit (LX277 - FH500V) . . . . .68.10 mm (2.681 in.)

0.50 mm (0.020 in.) Oversize Bore (LX288 - FH580V):
Standard . . . . 75.68 - 75.70 mm (2.979 - 2.980 in.)

0.50 mm (0.020 in.) Oversize Bore
(LX277 - FH500V) . . 68.48 - 68.50 mm (2.696 - 2.697 in.)

Wear Limit (LX288 - FH580V) . . . . 75.78 mm (2.983 in.)

Wear Limit (LX277 - FH500V) . . . . 68.60 mm (2.701 in.)

Cylinder Bore Out of Round (LX288 - FH580V):
Standard . . . . 0.01 mm (0.0004 in.)

Cylinder Bore Out of Round (LX277 - FH500V)

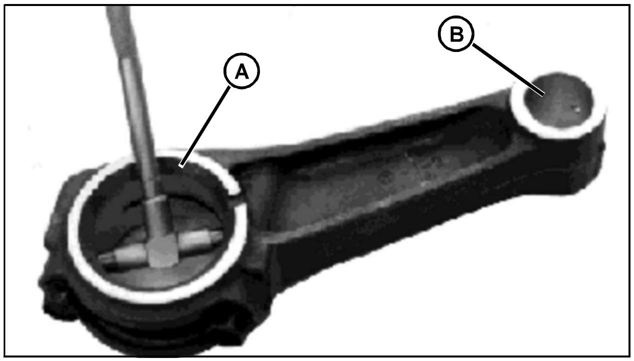
Wear Limit. . . . . 0.01 mm (0.004 in.)

If cylinder bore exceeds wear limit, rebore cylinder or replace cylinder block. See “Resize Cylinder Bore” on page 112.

NOTE: If cylinder is rebored, oversize piston and rings must be installed.

Connecting Rod:

1. Clean and inspect rod. Replace if scored.
2. Install connecting rod cap. Tighten to 9.8 N•m (87 lb-in.).



M50066

3. Measure connecting rod crankshaft bearing diameter (A) and piston pin diameter (B). Replace connecting rod if either measurement is greater than specifications.

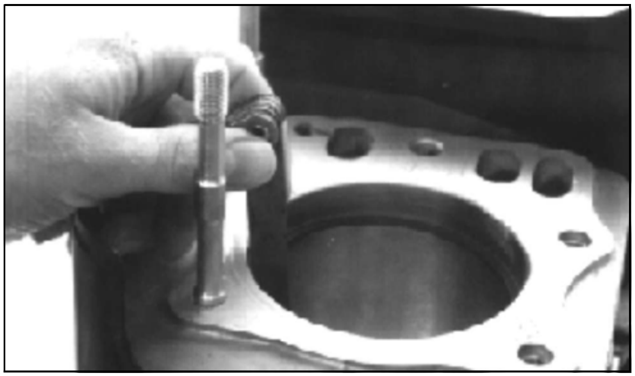
Connecting Rod Bearing ID (Wear Limit):

Crankshaft Bearing . . . . 38.055 mm (1.498 in.)

Piston Pin Bearing . . . . 16.05 mm (0.632 in.)

Piston Rings:

1. Measure thickness of top and second piston rings at several places. If thickness is less than 1.40 mm (0.055 in.), replace piston ring.



M50073

2. Check piston ring end gap. Install each ring squarely in bore approximately 25.4 mm (1.0 in.) down from top of cylinder.

3. Check end gap. Replace if end gap is greater than specifications.

End Gap Specifications:

Maximum End Gap	
Top Ring	**0.70 mm (0.028 in.)**
Second Ring	**0.78 mm (0.031 in.)**
Oil Control Ring (Side Rails)	**1.05 mm (0.041 in.)**

Analyze Crankshaft and Connecting Rod Wear

Procedure:

Check connecting rod and cap for damage or unusual wear patterns.

Lack of lubrication or improper lubrication can cause the connecting rod and cap to seize the crankshaft.

When the rod and cap seize to the crankshaft, the connecting rod and piston may both break causing other internal damage. Inspect block carefully before rebuilding engine.

Crankshaft and connecting rod damage can result from:

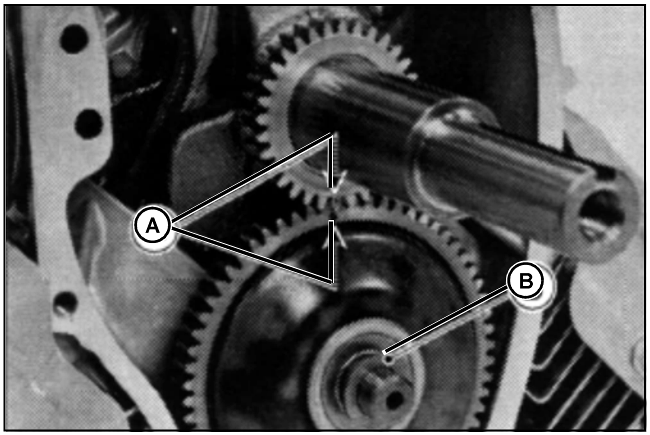
- Engine run low on oil or without oil.
- Oil not changed regularly.
- Bearing cap installed incorrectly.

Camshaft and Tappets

Removal:

1. Remove fuel pump.
2. Remove rocker arm assemblies.
3. Remove crankcase cover.

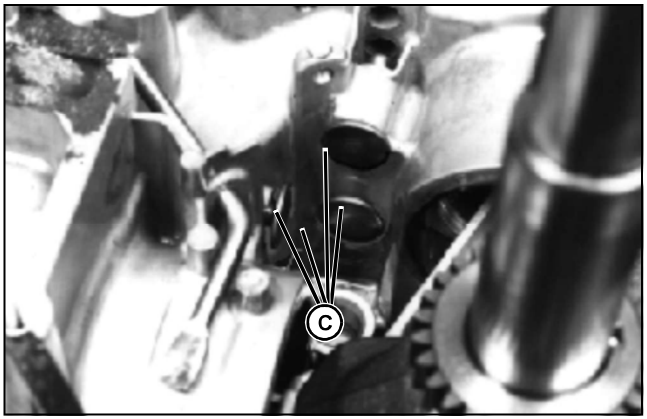
IMPORTANT: Avoid damage! Align timing marks to prevent damage to tappets when removing camshaft.



M95374

4. Rotate crankshaft until timing marks (A) align.
5. Remove and inspect camshaft (B).

NOTE: Mark tappets so they can be installed in their original guides during assembly.



M53975

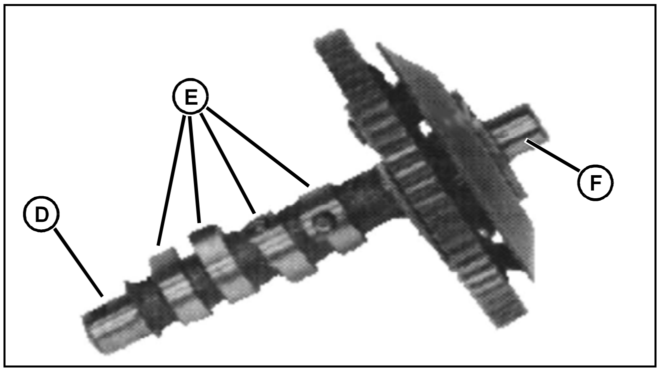
6. Remove and inspect tappets (C) for wear or damage. Replace if necessary.

Installation is done in the reverse order of removal.

- Align timing marks when installing camshaft.

Inspection:

1. Inspect camshaft for worn or broken teeth.



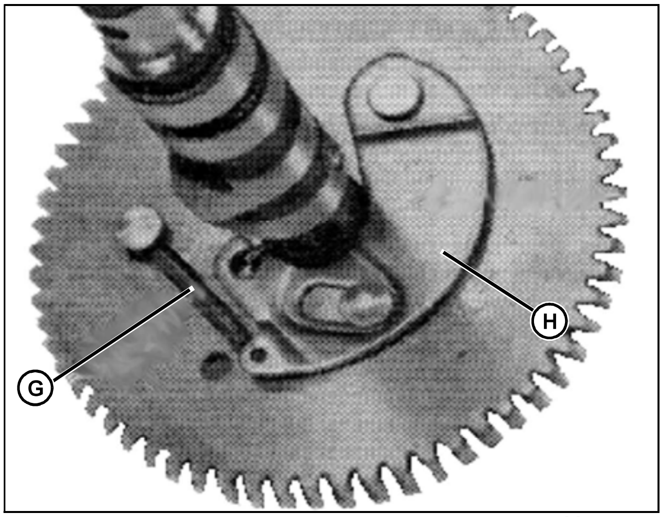
M95373

2. Measure PTO side journal (F), flywheel side journal (D) and lobes (E). Replace camshaft and tappets if any measurement is less than specifications.

Camshaft Specifications (Minimum):

Side Journals . . . . 15.985 mm (0.629 in.)

Cam Lobe Height . . . . 29.131 mm (1.147 in.)

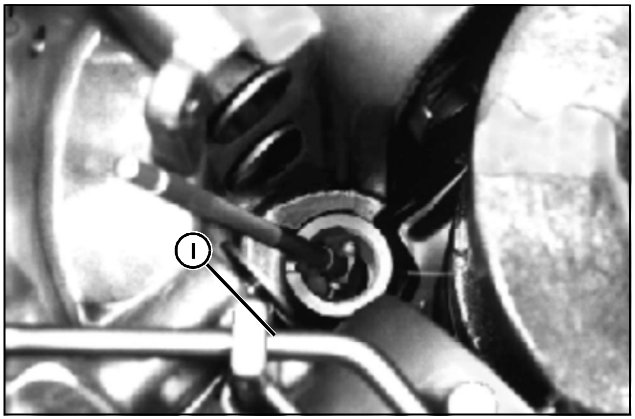


M95371

3. Inspect Automatic Compression Release weight (H) for damage.

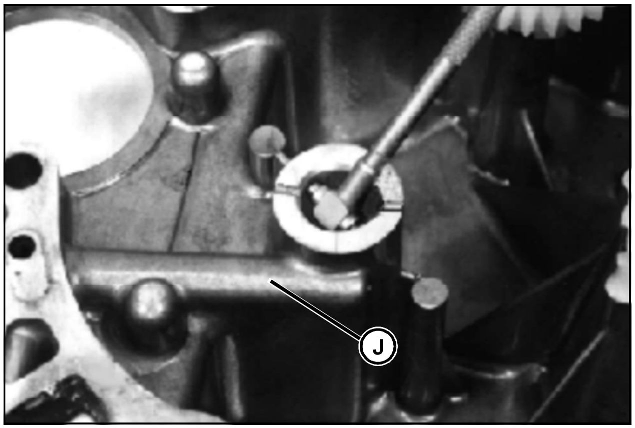
4. Inspect spring (G). Replace if worn or damaged.

5. Shake the camshaft assembly and check that the ACR weight (H) swings smoothly.



M51723

Picture Note: Cylinder Block Bearing



M51724

Picture Note: Crankcase Cover Bearing

6. Measure camshaft bearings in cylinder block (I) and crankcase (J) cover. Replace block or cover if either diameter is greater than 16.13 mm (0.635 in.).

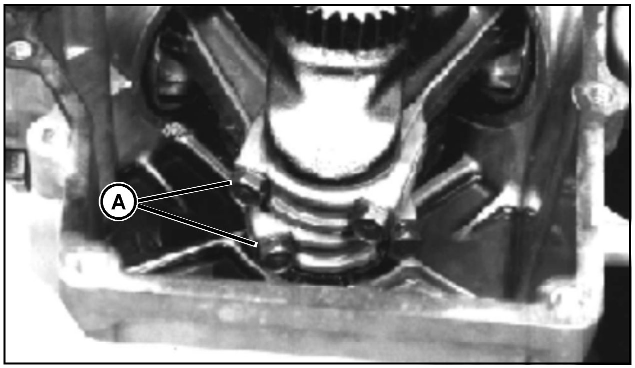
Crankshaft and Main Bearings

Removal:

1. Remove flywheel and split crankcase.
2. Remove camshaft.

IMPORTANT: Avoid damage! Connecting rod caps must be installed on the same connecting rods they were removed from.

3. Mark connecting rod caps to aid in installation.



M51726

4. Remove connecting rod caps (A) and push pistons to top of cylinder.

5. Remove crankshaft.

6. Inspect crankshaft for wear or damage.

Installation is done in the reverse order of removal.

1. Cover keyway on flywheel end of crankshaft with tape to prevent seal damage when installing crankshaft.

2. Apply a light film of clean engine oil on crankshaft bearing surfaces before installation.

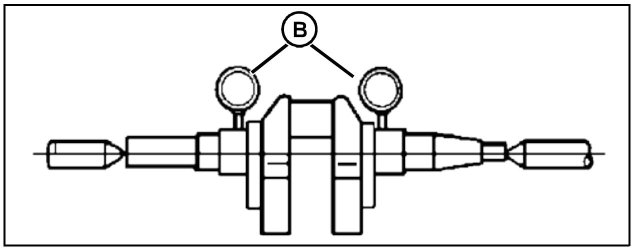
3. Pack oil seals with lithium base grease.

4. Install connecting rod caps and tighten to 9.8 N•m (87 lb-in.).

Inspection:

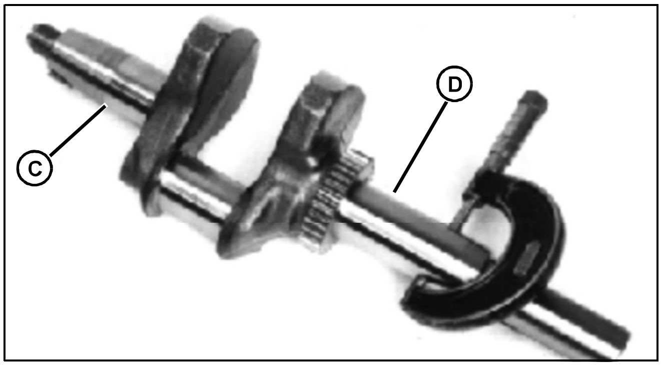
IMPORTANT: Avoid damage! A bent crankshaft must be replaced; it cannot be straightened.

1. Clean and inspect crankshaft. Replace if scratched or damaged.



M80432

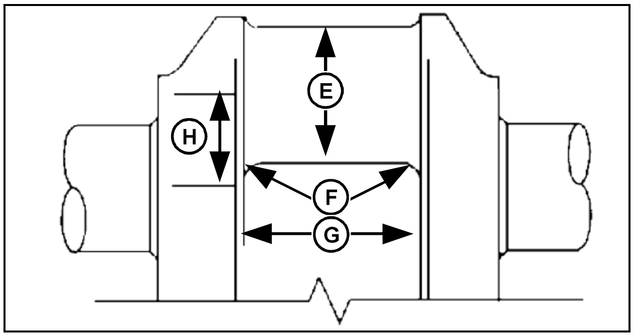
2. Place crankshaft into an alignment jig and slowly rotate crankshaft. Use dial indicators (B) to measure maximum Total Indicated Runout (TIR). If runout exceeds 0.05 mm (0.002 in.), replace crankshaft.



M51729

3. Measure main bearing journal diameters. If PTO side journal (D) OD is less than 34.90 mm (1.374 in.) replace crankshaft. If flywheel side journal (C) OD is less than 34.93 mm (1.375 in.) replace crankshaft.

NOTE: If the engine has had a previous overhaul, connecting rod journal may have been resized for undersized rod. A 0.50 mm (0.020 in.) undersized rod is available.



M57348

4. Measure connecting rod journal diameter (E) and inspect journal radii (F) for cracks. Connecting rod journal can be resized to accept undersized rod. Have grinding done by a reliable repair shop.

If undersized journal diameter is less than specifications, replace crankshaft.

Connecting Rod Journal ID (LX288 - FH580V) (Wear Limit):

Standard . . . . 38.055 mm (1.498 in.)

Connecting Rod Journal OD (LX277 - FH500V) (Wear Limit):

Standard . . . . .35.055 mm (1.380 in.)

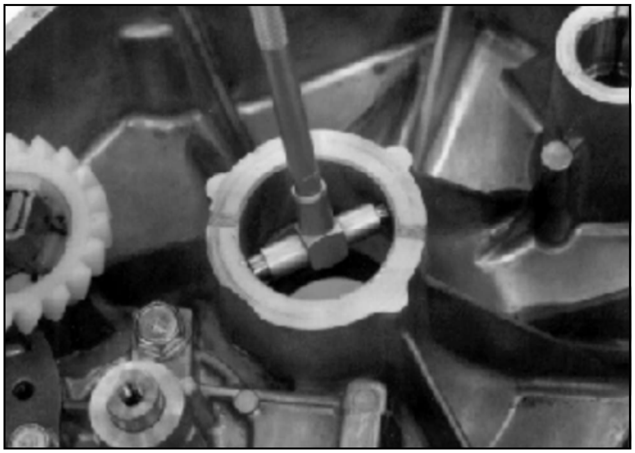
Resizing Specifications:

E. . . . . 37.457 - 37.470 mm (1.474 - 1.475 in.)

F . . . . 2.0 - 2.4 mm (0.0787 - 0.0945 in.)

G (Maximum) . . . . 39.50 mm (1.555 in.)

H. . . . . 33.95 - 34.05 mm (1.337 - 1.340 in.)



M50072

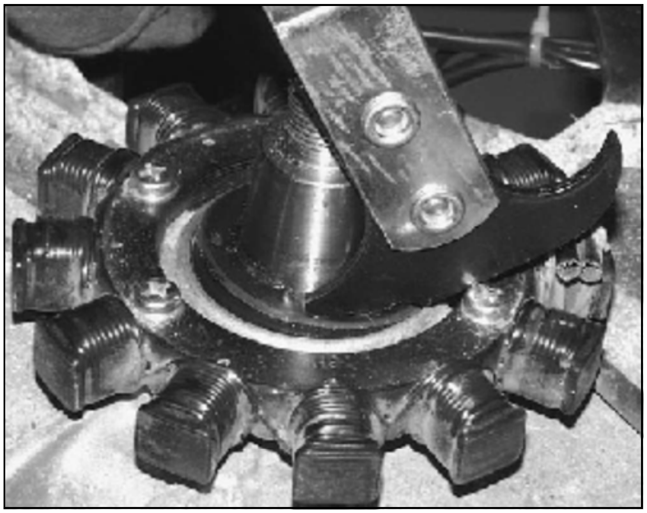
5. Measure crankshaft main bearing diameter in crankcase and crankcase cover. Replace crankcase cover or crankcase if diameter is greater than 35.15 mm (1.384 in.).

Crankshaft Oil Seals

NOTE: Oil seals can be replaced with crankshaft installed. Make sure oil seal removal tool does not contact crankshaft. If engine is disassembled, simply pry out seals with a large screwdriver and install new ones with a seal driver.

Replacement (Flywheel End):

1. Remove blower housing, fan, and flywheel.



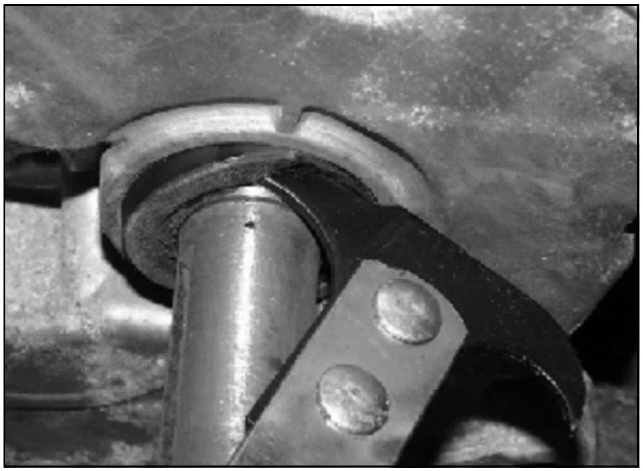
MX9582

2. Using care not to contact crankshaft or coils on stator, pry seal out of bore.

3. Apply lithium based grease inside lips of new seal. Install seal with lip toward inside of engine. Using a seal driver, install seal flush with top of bore.

Replacement (PTO End):

1. PTO End: Remove clutch and sheave assemblies. Remove engine from machine.



MX9596

2. Using care not to contact crankshaft, pry seal out of crankcase cover

3. Apply lithium based grease inside lips of new seal.

4. Install seal with lip toward inside of engine using a seal driver. Press in seals until flush with flange surface.

Deglaze Cylinder Bore

Procedure:

1. Deglaze cylinder bore using a rigid hone with a 220 to 300 grit stone.

2. Use hone as instructed by manufacturer to obtain 45° crosshatch pattern.

IMPORTANT: Avoid damage! Do not use gasoline, kerosene, or commercial solvent to clean cylinder bores. Solvents will not remove all abrasives from cylinder walls.

3. Clean cylinder walls using clean white rags and warm soapy water. Continue to clean cylinder until white rags show no discoloration.

Resize Cylinder Bore

Procedure:

IMPORTANT: Avoid damage! Check stone for wear or damage. Use correct stone for the job.

The cylinder block can be resized to use greater than 0.50 mm (0.020 in.) oversize pistons and rings. Have a reliable repair shop resize the block, or use the drill press and honing tool. Resize cylinder with a honing tool to initial and final bore specifications.

1. Align center of bore to drill press center.

2. Lower and raise hone until ends extend 20 - 25 mm (0.75 - 1.0 in.) past ends of cylinder.

3. Adjust hone so lower end is even with end of cylinder bore.

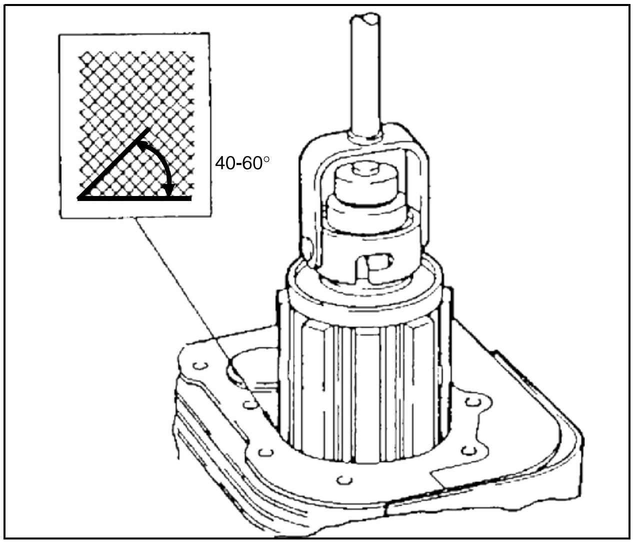
4. Adjust rigid hone stones until they contact narrowest point of cylinder.

5. Coat inside of cylinder with honing oil. Turn hone by hand. Adjust if too tight.

6. Run drill press between 200 - 250 rpm. Move hone up and down in cylinder approximately 20 times per minute.

7.

NOTE: Measure bore when cylinder is cool.



M82412A

8. Stop press and check cylinder diameter.

NOTE: Finish should not be smooth, but have a 40 -60° cross-hatch pattern.

9. Check bore for size, taper, and out-of-round.

10.Hone the cylinder an additional 0.006 - 0.008 mm (0.0002 - 0.0003 in.) for final bore specifications. This allows for shrinkage when cylinder cools.

IMPORTANT: Avoid damage! DO NOT use gasoline or commercial solvents to clean cylinder bores. Solvents will not remove metal particles produced during honing

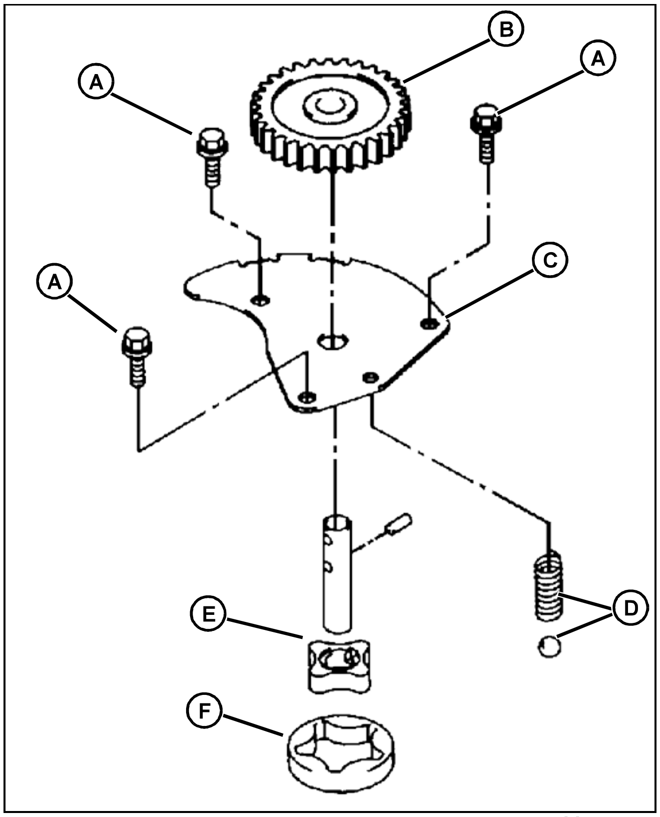
11.Clean the cylinder thoroughly using soap, warm water and clean rags. Continue to clean cylinder until white rags show no discoloration.

12.Dry the cylinder. Apply engine oil to cylinder wall.

Oil Pump Disassembly and Assembly

Disassembly:

1. Remove crankcase cover. See “Crankcase Cover Removal and Installation” on page 104.



M95415

2. Remove the three mounting cap screws (A) and lift the oil pump gear and shaft assembly (B) and cover plate (C) out of the crankcase.

3. Remove relief valve spring and ball (D).

4. Remove the inner (E) and outer (F) rotors

5. Inspect all parts for wear or damage.

Assembly is done in the reverse order of disassembly.

1. Fill rotor housing with engine oil for initial lubrication.

2. Install the outer (F) and inner (E) rotors

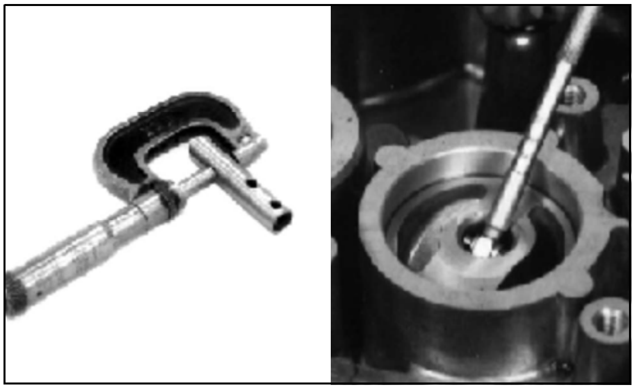
3. Install relief valve ball and spring (D).

4. Install oil pump gear and shaft assembly (B), cover plate (C), and secure with three cap screws (A).

5. Tighten the three cap screws (A) to 5.9 N•m (52 lb-in.).

Inspection:

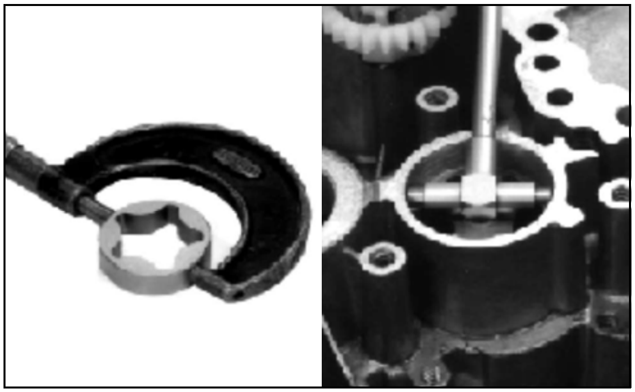
Inspect all parts for wear or damage. Replace as necessary.



M53968/M53969

1. Measure rotor shaft diameter. If shaft OD is less than 10.92 mm (0.430 in.), replace shaft.

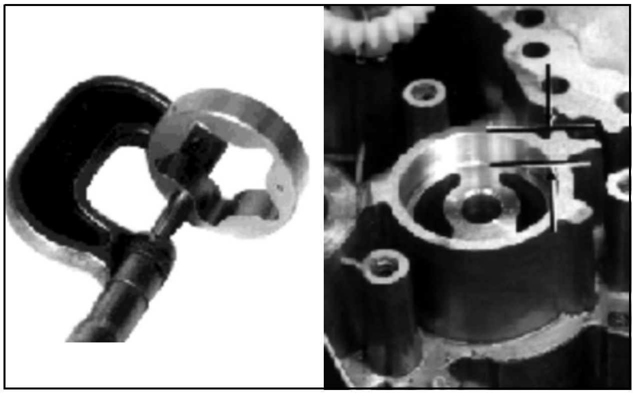
2. Measure rotor shaft bearing. If bearing ID is greater than 11.07 mm (0.436 in.), replace crankcase cover.



M53970/M53971

3. Measure outside diameter of outer rotor. If OD is less than 40.47 mm (1.593 in.), replace outer rotor.

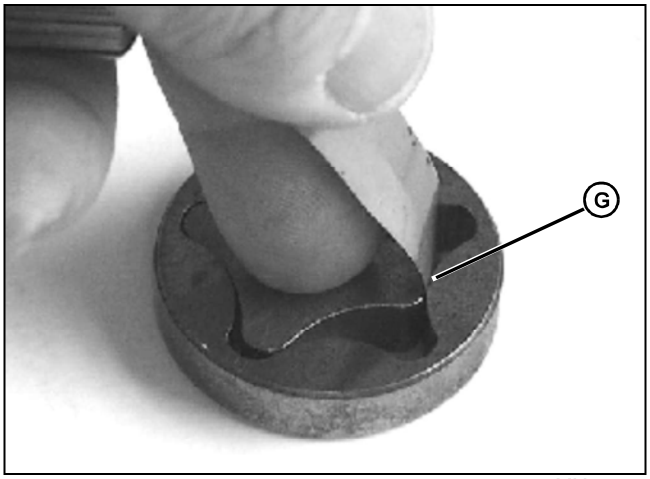
4. Measure inside diameter of rotor housing. If ID is greater than 40.80 mm (1.606 in.), replace crankcase cover.



M80015/M82908

5. Measure thickness of outer rotor. If thickness is less than 9.83 mm (0.387 in.), replace rotor.

6. Measure outer rotor housing depth. If depth is greater than 10.23 mm (0.403 in.), replace crankcase cover.



MX9543

7. Measure inner to outer rotor clearance (G) with a feeler gauge. If clearance is greater than 0.2 mm (0.008 in.), replace both rotors.

M80083

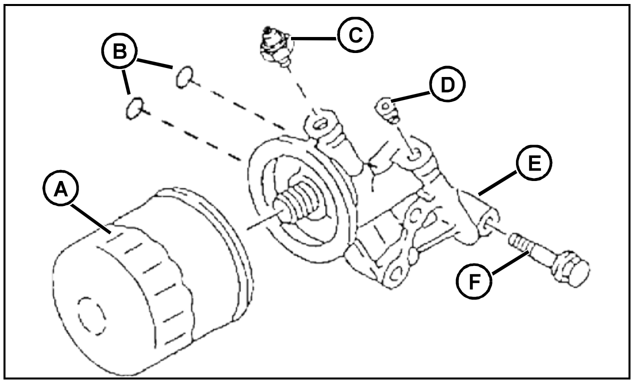
8. Measure relief valve spring. If free length is less than 19.50 mm (0.770 in.), replace spring.

Specifications:

Inner and Outer Rotor Clearance	**0.2 mm (0.008 in.)**
Outer Rotor Outside Diameter	**40.47 mm (1.5933 in.)**
Outer Rotor Thickness	**9.833 mm (0.387 in.)**
Pump Housing Inside Diameter	**40.801 mm (1.6063 in.)**
Pump Housing Depth	**10.23 mm (0.4028 in.)**
Pump Shaft Outside Diameter	**10.923 mm (0.440 in.)**
Pump Shaft Inside Diameter	**11.072 mm (0.436 in.)**
Relief Valve Spring Free Length	**19.5 mm (0.77 in.)**

Oil Filter Manifold

Removal and Installation:



M82801A

A - Oil Filter
B - Seals
C - Oil Pressure Sender Switch
D - Plug
E - Manifold
F - Mounting Cap Screw (3 used)

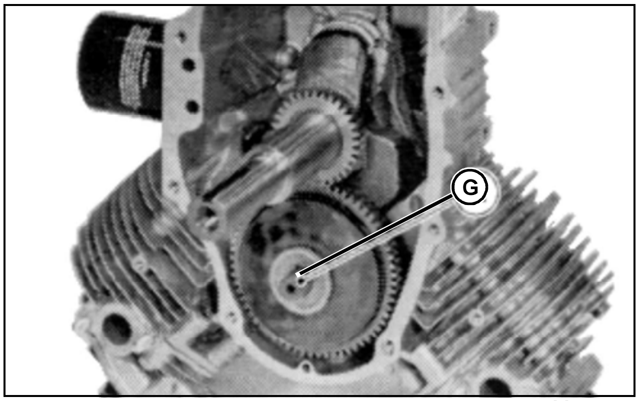
- Apply Pipe Sealant with TEFLON, to threads of oil pressure switch (C).

Governor Inspection and Replacement

Procedure:

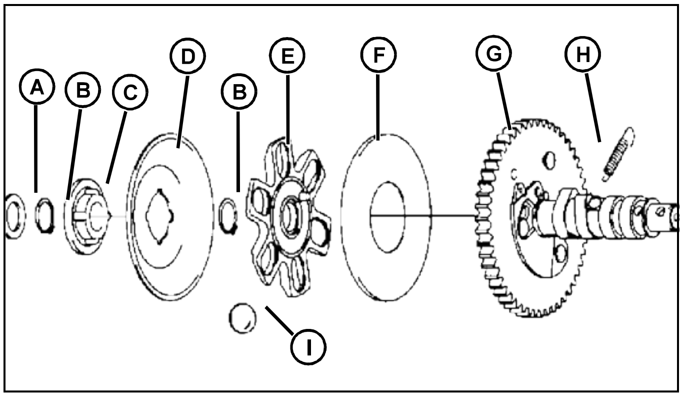
1. Remove crankcase cover. See “Crankcase Cover Removal and Installation” on page 104.

2. Remove rocker covers and push rods.



M95372

3. Turn engine upside down and remove camshaft (G).



M95423

A - Washer
B - Snap Ring
C - Sleeve
D - Governor Plate
E - Ball Guide
F - Ball Plate
G - Camshaft
H - Automatic Compression Release Spring
I - Steel Balls (6)

4. Disassemble the governor assembly from the camshaft.

5. Inspect governor for wear or damage. Replace if necessary.

6. When assembling, be sure the steel balls are seated in slots on the ball guide and that the snap rings are fully seated in their grooves.

Governor Shaft Inspection and Replacement

Removal:

NOTE: It is not necessary to remove governor shaft unless damaged.

1. Remove crankcase cover. See “Crankcase Cover Removal and Installation” on page 104.

2. Unscrew the governor shaft plate screws and pull the governor shaft out of the crankcase cover.

3. Replace the oil seal if the lip shows signs of leakage or it has been damaged.

4. Inspect governor shaft for wear or damage. Replace if necessary.

Installation is done in the reverse order of removal.

1. Apply clean engine oil to the governor shaft.

2. Insert the governor shaft into the crankcase.

3. Install the governor shaft plate to the shaft and tighten the screws to 2.0 N•m (17 lb-in.).

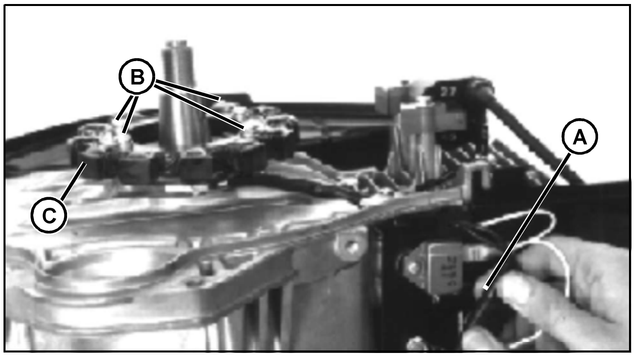
4. Check that governor shaft turns freely within its operating range.

5. If oil seal has been removed, press a new seal into crankcase with the seal lip to the inside.

6. Press the seal in to flush to 1.0 mm (0.04 in.) below crankcase surface.

Stator Removal and Installation

Removal:



M50146

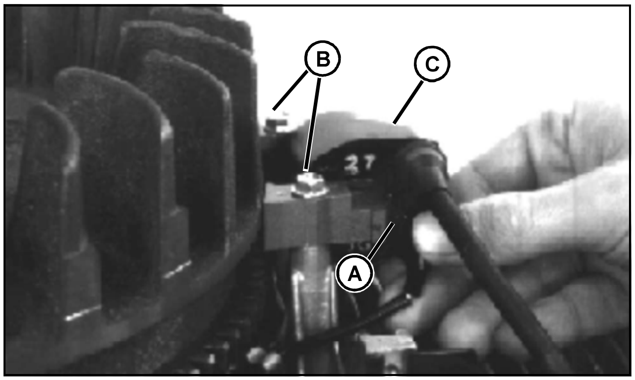
1. Remove blower housing and flywheel.
2. Disconnect stator lead (A).
3. Remove screws (B) and stator (C).

Installation is done in the reverse order of removal.

Armature Removal and Installation

Removal:

1. Remove blower housing. See “Blower Housing Removal and Installation” on page 96.

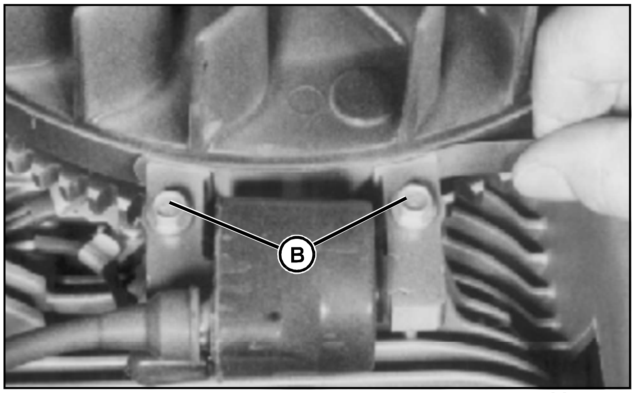


M50147

2. Disconnect wiring lead (A).
3. Remove cap screws (B) and armature with coil (C).
4. Test armature with coil. (See Test procedure.)

Installation is done in the reverse order of removal.

1. Adjust armature air gap. See “Ignition Coil Air Gap Adjustment” on page 92.



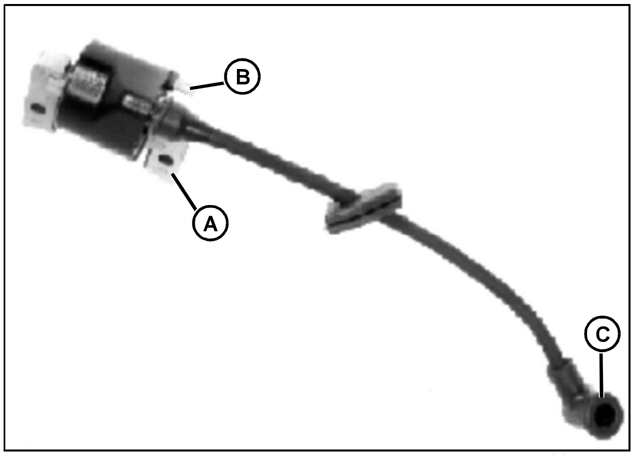
M45869

2. Center flywheel magnet under armature.
3. Insert a 0.30 mm (0.012 in.) feeler gauge between flywheel and armature.
4. Push armature against flywheel and tighten screws (B) to 7.8 N•m (69 lb-in.).
5. Turn flywheel to remove feeler gauge.

Air Gap Specifications:

Air Gap . . . . 0.2 - 0.4 mm (0.008 - 0.016 in.)

Test:



M82802

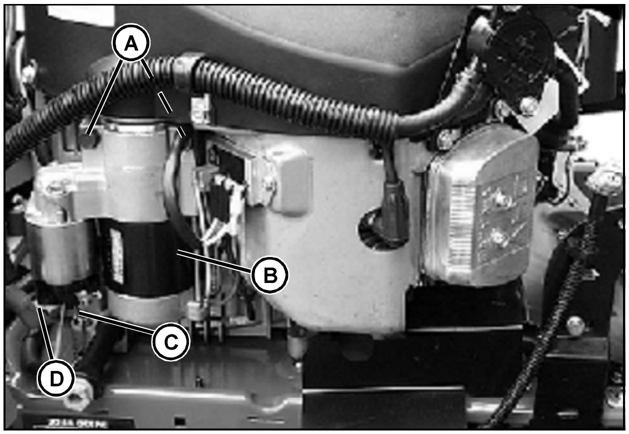
1. Measure resistance between each point as shown in the chart below. If resistance is not within specification, replace armature with coil.

	A	B	C
A		2 - 18 k	2 - 18 k
B			
C	2 - 18 k	2 - 18 k	

Starting Motor Removal and Installation

Removal:

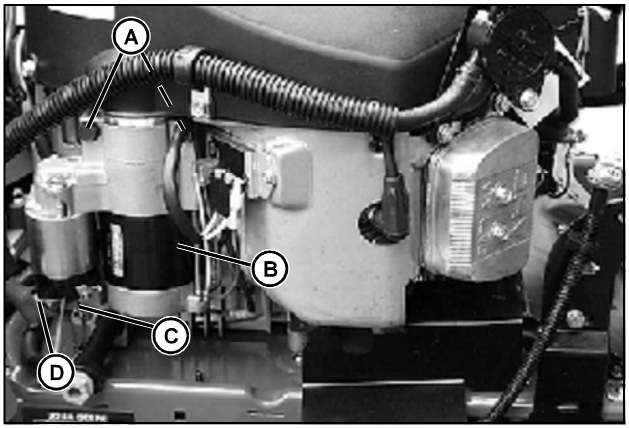
1. Disconnect negative (-) battery terminal.



MX16330

2. Disconnect positive (+) battery cable and orange wire from large terminal (D) of starter solenoid. Disconnect purple wire (C) from solenoid.
3. Remove two cap screws (A) and starter assembly (B).

Installation:



MX16330

1. Install starter assembly (B) and secure with two cap screws (A). Tighten two cap screws (A) to 15 N•m (132 lb-in.).
2. Connect positive (+) battery cable and orange wire to large terminal (D) of starter solenoid. Tighten nut securing wires to 9.8 N•m (84 lb-in.). Connect purple wire (C) to solenoid.
3. Connect negative (-) battery terminal.

Starting Motor Disassembly and Assembly

Analyze Condition:

The starting motor overheats because of:

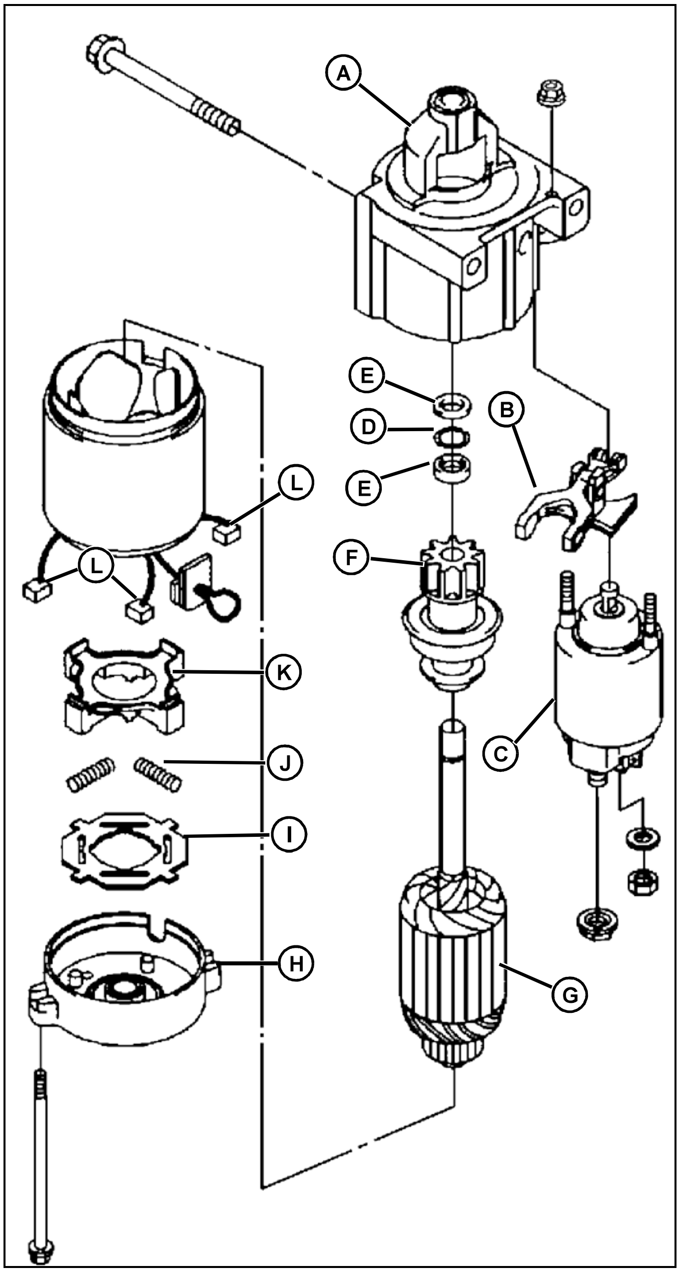
- Long cranking.
- Armature binding.

The starting motor operates poorly because of:

- Armature binding.
- Dirty or damaged starting motor drive.
- Badly worn brushes or weak brush springs.
- Excessive voltage drop in cranking system.
- Battery or wiring defective.
- Shorts, opens, or grounds in armature.

NOTE: Starting motor repair is limited to brushes, end caps, and starting motor drive. Fields in starting motor are permanent magnets and are not serviceable. If housing or armature is damaged, replace starting motor.

Disassembly and Assembly:



M94902

A - Front Cover
B - Shift Lever
C - Solenoid
D - Retaining Clip
E - Pinion Stopper
F - Pinion
G - Armature
H - End Cover
I - Insulator
J - Brush Springs
K - Brush Holder
L - Brush

1. Mark body and covers for correct alignment during reassembly.

2. Push pinion stopper (E) toward pinion (F) to remove retaining clip (D).

3. Inspect parts for wear or damage.

4. Test solenoid (C), starting motor armature (G) and brushes (O). (See Inspection/Test procedures.)

Assembly is done in the reverse order of disassembly.

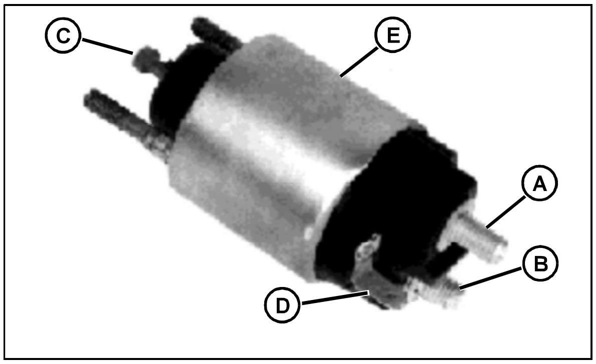
Apply a thin coat of multipurpose grease to:

- Sliding surfaces of armature and solenoid shift lever.
- Armature shaft spline.
- Points where shaft contacts cover.

Inspection/Test:

1. Measure field coil brush lengths. If any one brush length is less than 6.4 mm (0.250 in.), replace all four brushes.

2. Inspect brush springs for wear or damage. Replace if necessary.



M51705

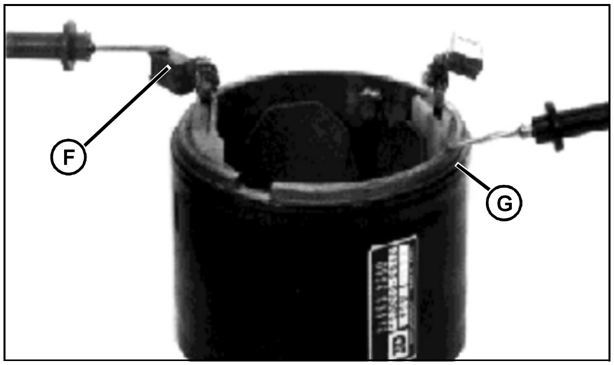
3. Test solenoid terminals (A and B) for continuity. There should be no continuity.

4. Depress switch arm (C). There should be continuity when arm is fully depressed.

5. Test for open circuits between terminal (B) and tang (D). There should be continuity.

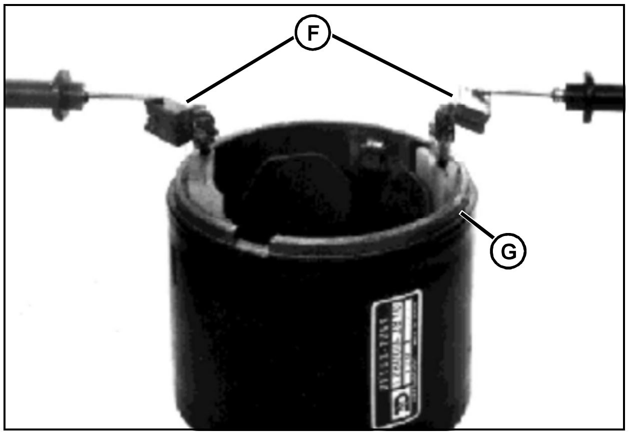
6. Test for open circuits between tang (D) and body (E). There should be continuity.

7. If solenoid fails any test, it is defective and must be replaced.



M50115

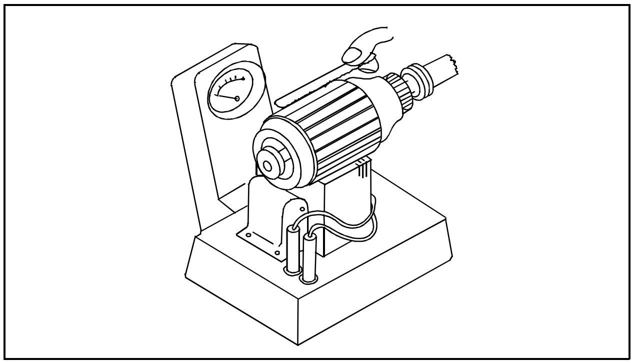
8. Test for grounded field winding. Touch one probe of tester to field coil brush (F) and the other probe to the field coil housing (G). Be sure the brush lead is not touching the frame. If there is continuity, the coil is grounded and the field coil housing must be replaced.



M50116

9. Test for open field coil. Touch one probe of tester to each field coil brush (F). If there is no continuity, the field coil is open and the field coil housing assembly (G) must be replaced.

IMPORTANT: Avoid damage! Do not clean armature with solvent. Solvent can damage insulation on windings. Use only mineral spirits and a brush.



MIF

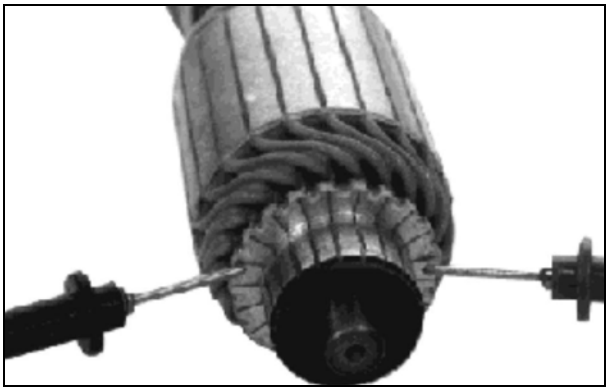
10.Locate short circuits by rotating armature on a growler while holding a hacksaw blade or steel strip on armature. The hacksaw blade will vibrate in area of short circuit.

NOTE: Shorts between bars are sometimes caused by dirt or copper between bars. Inspect for this condition.

11.If test indicates short circuited windings, clean the commutator of dust and fillings. Check armature again. If test still indicates short circuit, replace armature.

M50112

12.Test for grounded windings using an ohmmeter. Touch probes on each commutator bar. Armature windings are connected in parallel, so each commutator bar needs to be checked. If test shows continuity, a winding is grounded and the armature must be replaced.



M50113

13.Test for open circuited windings using an ohmmeter. Touch probes on each commutator bar. If test shows no continuity, there is an open circuit and armature must be replaced.

No-Load Amperage Draw and RPM Test

Reason:

To determine if starting motor is binding or has excessive amperage draw under no-load.

Test Equipment:

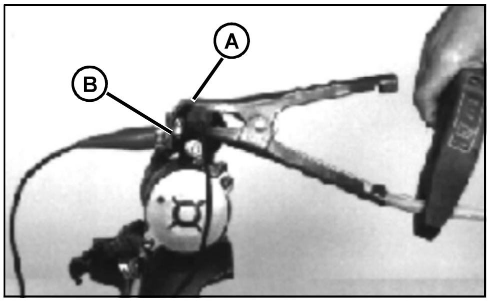
- JT05712 Current Gun
- JT03719 Photo Tachometer

Procedure:

IMPORTANT: Avoid damage! Complete this test in 20 seconds or less to prevent starting motor damage.

NOTE: Check that battery is fully charged and of proper size to ensure accuracy of test.

1. Connect jumper cables to battery.



M45867

2. Connect negative cable to starting motor body. Connect positive cable to terminal (A).

3. Use jumper wire to briefly connect terminals (A and B). Measure starting motor amperage and rpm. Maximum starting motor amperage is 50 amps at 5000 rpm.

Results:

- If amperage is out of specification, check for binding or seizing bearings, sticking brushes, dirty or worn commutator. Repair or replace starting motor.

ENGINE - KAWASAKI (LIQUID-COOLED) TABLE OF CONTENTS

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ENGINE - KAWASAKI (LIQUID-COOLED) SPECIFICATIONS

Specifications

General Specifications

Make	Kawasaki V-Twin
Model Number	FD501V-AS04
Horsepower	12.7 kW (17 hp)
Bore	67 mm (2.64 in.)
Stroke	71.19 mm (2.80 in.)
Displacement	501 cm3 (30.6 cu in.)
Cylinders	2 (V-twin)
Stroke/Cycle	4
Valves	Overhead Valves
Lubrication	Fully Pressurized

Crankcase Oil Capacity

w/o Oil Filter	1.5 L (1.6 qt)
w/ Oil Filter	1.8 L (1.9 qt)

Oil Filter	Single Element, Full Flow, Spin-On Filter
Cooling System	Liquid Cooled
Air Cleaner	Dry Replaceable with Foam Pre-cleaner
Muffler	Horizontal Discharge Below Frame
Spark Plug Gap	0.7 mm (0.028 in.)
Spark Plug Torque	20 N•m (15 lb-ft)

Test and Adjustment Specifications

Slow Idle	1550 ± 150 rpm
Fast Idle	3550 ± 50 rpm
Choke Arm Gap	0.25 - 3.0 mm (0.01 - 0.12 in.)
Ignition Air Gap	fixed position no adjustment

Cylinders:

Compression Pressure (Minimum)	1171 kPa (170 psi)
Difference Between Cylinders (Maximum)	97 kPa (14 psi)
Valve Clearance (Cold)	0.15 mm (0.006 in.)
Crankcase Vacuum	1.27 - 38.1 cm (0.5 - 15.0 in.)
Engine Oil Pressure at Fast Idle (Minimum)	276 kPa (40 psi)
Engine Oil Pressure at Fast Idle (Maximum) - Relief Valve Pressure	296 kPa (43 psi)

Fuel Pump:

Pressure at Slow Idle (Minimum)	2.45 kPa (0.36 psi)
Flow Volume at Slow Idle (Minimum)	800 mL/60 seconds (0.8 qt/60 seconds)
Fuel Pump Push Rod Bend (Maximum)	0.05 mm (0.002 in.)

Cooling System:

Operating Pressure

Minimum	90 kPa (13 psi)
Maximum	117 kPa (17 psi)

Radiator Cap Relief Pressure	73 - 103 kPa (10.6 - 14.9 psi)
Vacuum Valve	4.9 kPa (0.71 psi)
Coolant Temperature Switch Continuity (On)	107 - 113° C (225 - 235° F)
Capacity	2.10 L (2.2 US qt)

Repair Specifications

Cooling System:

Thermostat

Begin Opening	63 - 66° C (145 - 150° F)
Fully Open	80° C (176° F)
Impeller Shaft OD (Minimum)	9.935 mm (0.3911 in.)
Shaft Bore ID (Maximum)	10.09 mm (0.397 in.)

Rocker Arm Assembly:

Shaft OD (Minimum)	11.95 mm (0.470 in.)
Bearing ID (Maximum)	12.07 mm (0.475 in.)
Maximum Push Rod Bend	0.80 mm (0.031 in.)
Breather Reed Valve Tip Air Gap	0.2 mm (0.008 in.)

Cylinder Head:

Cylinder Head Distortion (Maximum)	0.06 mm (0.002 in.)
Valve Guide ID (Maximum)	5.06 mm (0.199 in.)
Valve Seat Width	0.5 - 1.1 mm (0.02 - 0.043 in.)
Valve Spring Free Length (Minimum)	27.30 mm (1.074 in.)

Intake and Exhaust Valves:

Valve Stem OD (Minimum)

Intake	4.93 mm (0.194 in.)
Exhaust	4.92 mm (0.193 in.)
Valve Stem Bend (Maximum)	0.03 mm (0.001 in.)
Valve Seating Surface (Standard)	0.80 mm (0.031 in.)
Valve Seat and Face Angle	45°
Valve Margin (Minimum)	0.50 mm (0.020 in.)
Valve Narrow Angle	30°

Piston Assembly:

Piston Ring Side Clearance (Maximum)

Compression Ring Grooves	0.10 mm (0.004 in.)
Oil Control Rings Groove	Not Measured

Piston Ring End Gap (Maximum)

Compression Rings	1.00 mm (0.040 in.)
Oil Control Rings	Not Measured

Piston Pin

Pin OD (Minimum)	15.98 mm (0.629 in.)

Bore ID (Maximum)	**16.04 mm (0.631 in.)**

Piston OD

Standard Piston	**66.950 - 66.965 mm (2.6358 - 2.6364 in.)**
Oversize Piston - 0.50 mm (0.020 in.)	**67.450 - 67.465 mm (2.655 - 2.656 in.)**
Piston-to-Cylinder Bore Clearance	**0.015 - 0.150 mm (0.0006 - 0.0059 in.)**

Cylinder Bore ID

Standard	**66.980 - 67.000 mm (2.637 - 2.638 in.)**
Wear Limit (Maximum)	**67.06 mm (2.639 in.)**

Oversize Bore - 0.50 mm (0.020 in.)

Standard	**67.48 - 67.50 mm (2.656 - 2.657 in.)**
Wear Limit (Maximum)	**67.560 mm (2.659 in.)**

Connecting Rod Bearing ID (Maximum)

Crankshaft Bearing ID	**31.06 mm (1.223 in.)**
Piston Pin Bearing ID (Maximum)	**16.05 mm (0.632 in.)**

Camshaft Specifications:

PTO Side Journal (Minimum)	**13.91 mm (0.548 in.)**
Flywheel Side Journal (Minimum)	**13.91 mm (0.548 in.)**
Cam Lobe Height (Minimum)	**24.43 mm (0.962 in.)**
Fuel Pump Lobe Height (Minimum)	**19.50 mm (0.760 in.)**

Oil Pump:

Rotor Shaft

Shaft OD (Minimum)	**10.92 mm (0.430 in.)**
Shaft Bearing ID (Maximum)	**11.07 mm (0.436 in.)**

Outer Rotor

Rotor OD (Minimum)	**40.43 mm (1.592 in.)**
Bearing ID (Maximum)	**40.80 mm (1.606 in.)**
Thickness (Maximum)	**9.83 mm (0.387 in.)**

Inner and Outer Rotor Clearance (Maximum)	**0.3 mm (0.012 in.)**
Pump Housing Depth (Maximum)	**10.23 mm (0.403 in.)**
Spring Free Length (Minimum)	**19.00 mm (0.748 in.)**
Oil Pressure Sensor Continuity (On)	**98 kPa (14.2 psi)**
Oil Filter Bypass Valve Opening Pressure	**78.5 - 117.5 kPa (11.4 - 17.1 psi)**

Governor:

Governor Mounting Shaft Height	**32.2 - 32.8 mm (1.267 - 1.291 in.)**
Governor Lever-to-Shaft Position	**7 mm (0.276 in.) from end of shaft**
Governor Shaft Seal Depth	**1 mm (0.040 in.) below crankcase surface**

Starting Motor:

Maximum Amperage (No Load)	**50 amps at 6000 rpm**
Brush Length (Minimum)	**6 mm (0.240 in.)**

Torque Specifications (Alphabetical)

Carburetor	
Mounting Stud Nut Torque	**17 N•m (150 lb-in.)**
Intake Elbow Mounting Cap Screw Torque	**8 N•m (71 lb-in.)**
Connecting Rod Cap Screw Torque	**12 N•m (106 lb-in.)**
Cooling Fan Mounting Cap Screw Torque	**6 N•m (53 lb-in.)**
Cooling Air Duct	
Mounting Cap Screw Torque	**6 N•m (53 lb-in.)**
Mounting Stud Torque	**6 N•m (53 lb-in.)**
Coolant Overflow Reservoir Mounting Cap Screw Torque	**4 N•m (35 lb-in.)**
Coolant Pump Mounting Cap Screw Torque	
Cover-to-Crankcase	**21 N•m (186 lb-in.)**
Pump-to-Cover	**9 N•m (80 lb-in.)**
Crankcase Cover Mounting Cap Screw Torque	**21 N•m (186 lb-in.)**
Cylinder Head Cap Screw Torque (in Sequence)	
Initial Torque	**13 N•m (115 lb-in.)**
Final Torque	**21 N•m (186 lb-in.)**
Engine Mounting Cap Screw Torque	**34 N•m (300 lb-in.)**
Flywheel Mounting Nut Torque	**88 N•m (65 lb-ft)**
Fuel Pump Mounting Cap Screw Torque	**16 N•m (142 lb-in.)**
Governor Arm Clamp Nut Torque	**7.8 N•m (69 lb-in.)**
Governor Lever Nut Torque	**7.8 N•m (69 lb-in.)**
Intake Manifold Mounting Cap Screw	
Initial Torque	**3 N•m (27 lb-in.)**
Final Torque	**6 N•m (53 lb-in.)**
Oil Drain Plug Torque	**25 N•m (220 lb-in.)**
Oil Pump Mounting Cap Screw Torque	**7.8 N•m (69 lb-in.)**
Rocker Arm	
Cap Screw Torque	**6 N•m (53 lb-in.)**
Jam Nut Torque	**9 N•m (79 lb-in.)**
Rocker Cover Cap Screw Torque	**5.9 N•m (52 lb-in.)**
Spark Plug Torque	**20 N•m (15 lb-ft)**

Tools and Materials

Special or Essential Tools

Order tools according to information given in the U.S. SERVICEGARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

Special or Required Tools

Tool Name	Tool No.	Tool Use
Spark Tester	D-05351ST	Used to check overall condition of ignition system
Reaming Tool (7.05 mm)	D20020WI	Used to clean or size valve guides
Pressure Gauge	JDG356	Used to check fuel pump performance
Reaming Tool (7.25 mm)	JDG705	Used to bore oversize valve guide
Compression Gauge	JDM59	Used to check engine compression
Valve Spring Compressor	JDM70	Used to remove and install valve springs
6.4 mm (0.25 in.) Drill Bit	- - -	Throttle and choke adjustment
Dial Indicator	- - -	Automatic compression relief test, valve inspection, crankshaft end play
Digital Pulse Tachometer	JT07270	Slow and/or fast idle adjustment
Current Gun	JT05712	Used to check starter performance
Photo Tachometer	JT05719	Slow and/or fast idle adjustment
Spark Plug Ground	JDM74A5	Used to prevent accidental engine starting during tests
Cylinder Leak Tester	JT035029	Cylinder leak test
U-Tube Manometer Test Kit; or Crankcase Vacuum Test Kit	JT05697 JT03503	Crankcase vacuum check
Oil Pressure Test Adapter w/ O-ring (required ONLY on engines without test ports) Connector Hose Assembly Coupler Gauge, 0 - 700 kPa (0 - 100 psi)	JT07262 JT05487 JT03017 JT03262 JT07034	Oil pressure test
Cooling System Pressure Pump	D05104ST	Used to check cooling system pressure
Radiator Pressure Test Kit (Adapters)	JDG692	Used to adapt D05104ST Cooling System Pressure Pump to cooling system when performing Cooling System Pressure Test. Also used when performing Radiator Cap Pressure Test
Adaptor	JDG472	Used to connect compressed air source to cylinder when performing Radiator Bubble Test
Lapping Tool	- - -	Valve lapping

Other Materials

Other Material

Part No.	Part Name	Part Use
M79292	MPG-2® Multipurpose Grease	Apply to engine crankshaft
- - -	SCOTCH-BRITE® Abrasive Sheets/Pads	Clean cylinder head
- - -	Valve Guide Cleaner	Clean valve guides
- - -	Stanisol (or Kerosene)	Finish ream valve guides
- - -	Lithium Base Grease	Pack oil seals
- - -	Mineral Spirits	Clean armature
- - -	Valve Lap Compound	Lap valves
T43512 / TY9473 / 242	Thread Lock and Sealer (Medium Strength)	Apply to threads of throttle and choke plate screws
TY15130 / 395	LOCTITE® Form-in-Place Gasket	Rocker arm cover mating surfaces

MPG-2, is a registered trademark of DuBois USA.

LOCTITE, is a registered trademark of the Loctite Corp.

SCOTCH-BRITE, is a register trademark of the 3M Co.

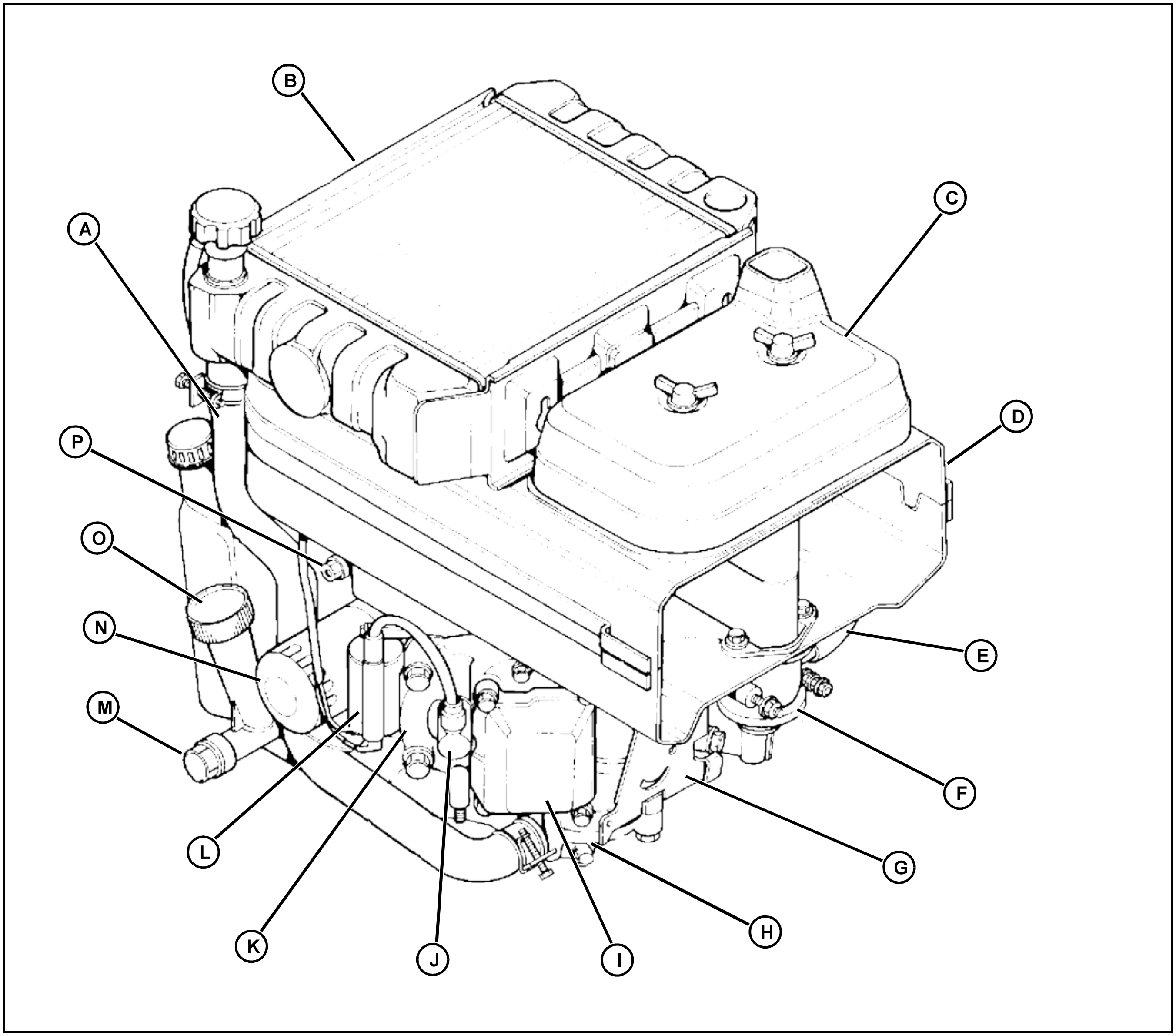
Service Parts Kits

The following kits are available through your parts catalog:

- Carburetor
- Gasket Kit
- Jet Kit
- Air Cleaner Bolt and Washer Kit
- Coolant Pump Gasket Kit
- Dipstick Tube Gasket Kit
- Rocker Arm and Shaft Kit
- Intake Valve Kit
- Exhaust Valve Kit
- Camshaft and Tappet Kit
- Piston Ring Kit (Standard)
- Piston Ring Kit (Oversize)
- Oversized Piston
- Overhaul Gasket Kit
- Engine Short Block Kit
- Oil Pump Kit
- Throttle Panel Kit
- Starting Motor Brush Kit
- Clutch Kit

Component Location

Exterior Engine Components

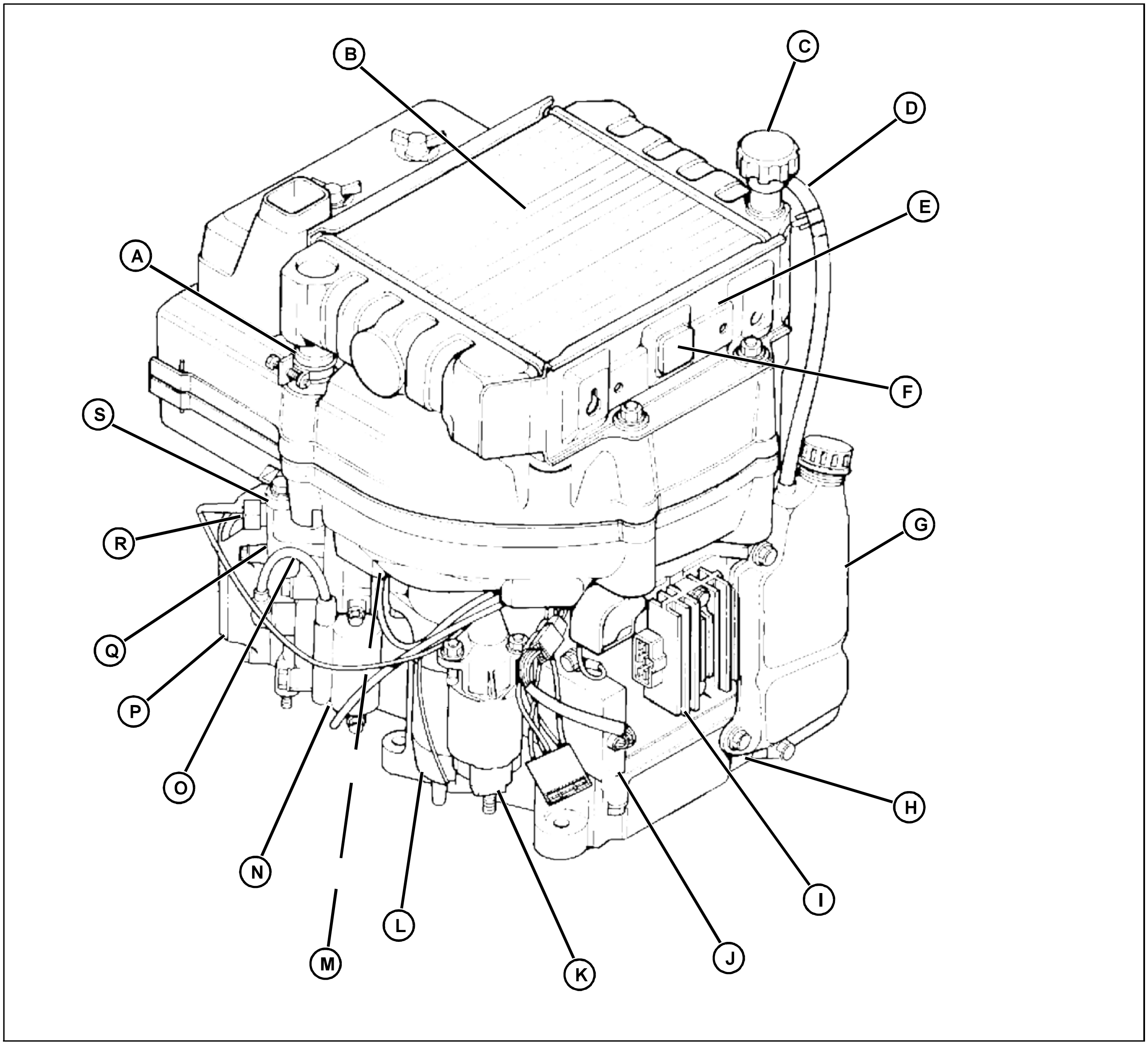


M45816

Right Side Shown

A - Radiator Outlet Hose
B - Radiator
C - Air Cleaner Assembly
D - Cooling Air Duct
E - Breather Hose
F - Fuel Pump
G - Throttle Control Plate
H - Coolant Pump
I - Rocker Arm Cover
J - Spark Plug Lead
K - Cylinder Head
L - Ignition Coil
M - Drain Plug
N - Oil Filter
O - Oil Dipstick
P - Oil Pressure Switch

ENGINE - KAWASAKI (LIQUID-COOLED) COMPONENT LOCATION

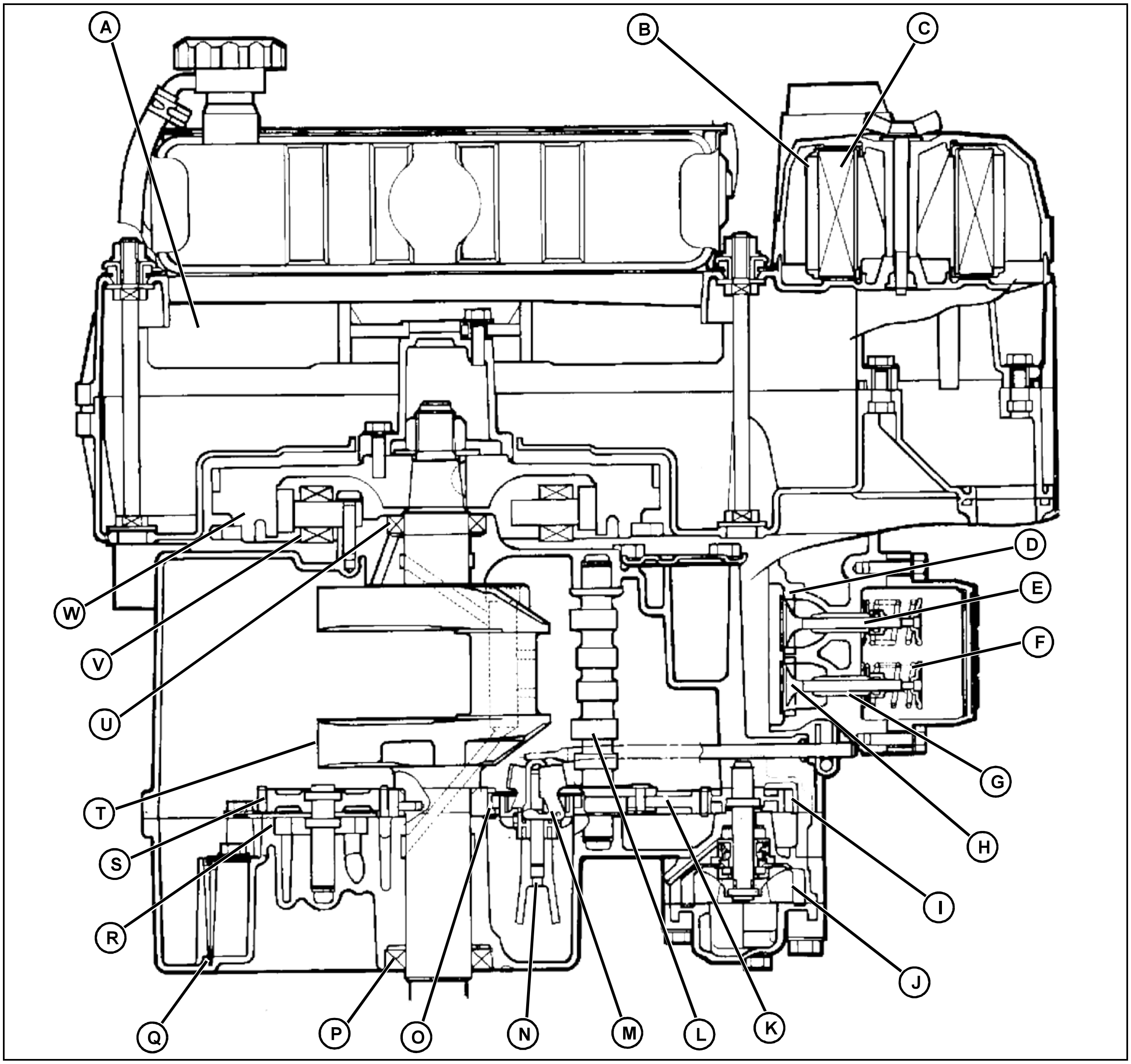


M45645

Left Side Shown

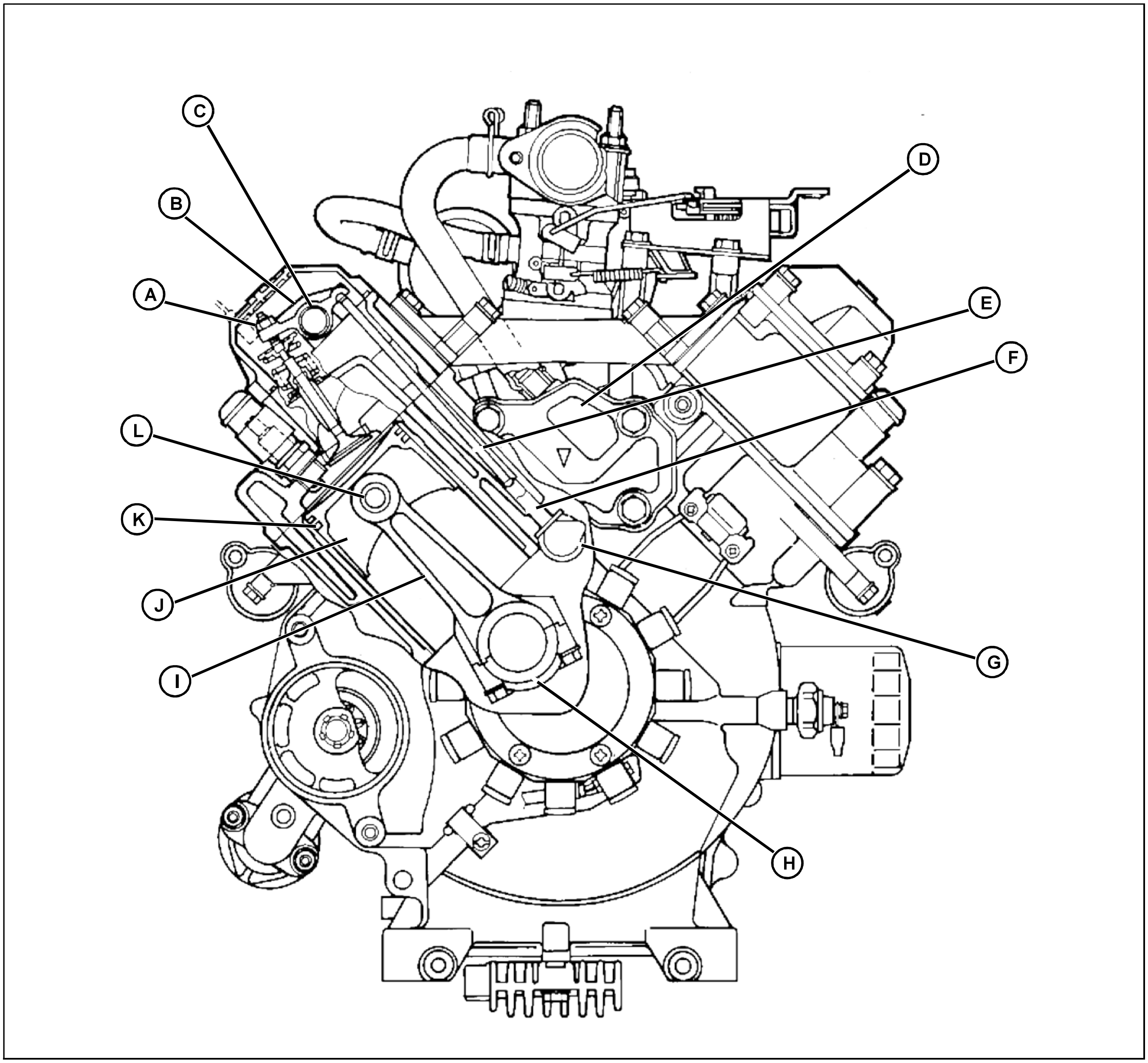
A - Radiator Inlet Hose
B - Radiator Screen
C - Radiator Cap
D - Overflow Hose
E - Radiator
F - Cooling Air Duct
G - Coolant Overflow Reservoir
H - Crankcase Cover
I - Voltage Regulator/Rectifier
J - Ignition Module
K - Starter Solenoid
L - Starter
M - Pulser Coil
N - Ignition Coil
O - Spark Plug Lead
P - Rocker Arm Cover
Q - Cylinder Head
R - Coolant Temperature Switch
S - Thermostat Housing

Internal Engine Components



Side View Cutaway

- **A - Cooling Fan**
- **B - Air Cleaner Foam Element**
- **C - Air Cleaner Paper Element**
- **D - Valve Seal**
- **E - Intake Valve**
- **F - Valve Springs**
- **G - Valve Guide**
- **H - Exhaust Valve**
- **I - Coolant Pump Gear**
- **J - Coolant Pump Impeller**
- **K - Camshaft Gear**
- **L - Camshaft**
- **M - Governor Flyweights**
- **N - Governor Shaft**
- **O - Governor Gear**
- **P - Lower Main Bearing and Seal**
- **Q - Oil Pickup Screen**
- **R - Oil Pump**
- **S - Oil Pump Gear**
- **T - Crankshaft**
- **U - Upper Main Bearing and Seal**
- **V - Stator**
- **W - Flywheel**



M45647

Top View Cutaway

A - Adjusting Screw and Locknut
B - Rocker Arm
C - Rocker Arm Shaft
D - Breather
E - Push Rod
F - Tappet
G - Camshaft
H - Connecting Rod Cap
I - Connecting Rod
J - Piston
K - Piston Rings
L - Piston Pin

Theory of Operation

Lubrication System Operation

Function:

To provide pressurized oil to lubricate internal engine components.

Theory of Operation:

A positive displacement gerotor pump is used to pressurize the lubrication system. The lubrication system is protected by an oil pressure relief valve, low oil pressure switch, and an oil filter with bypass valve.

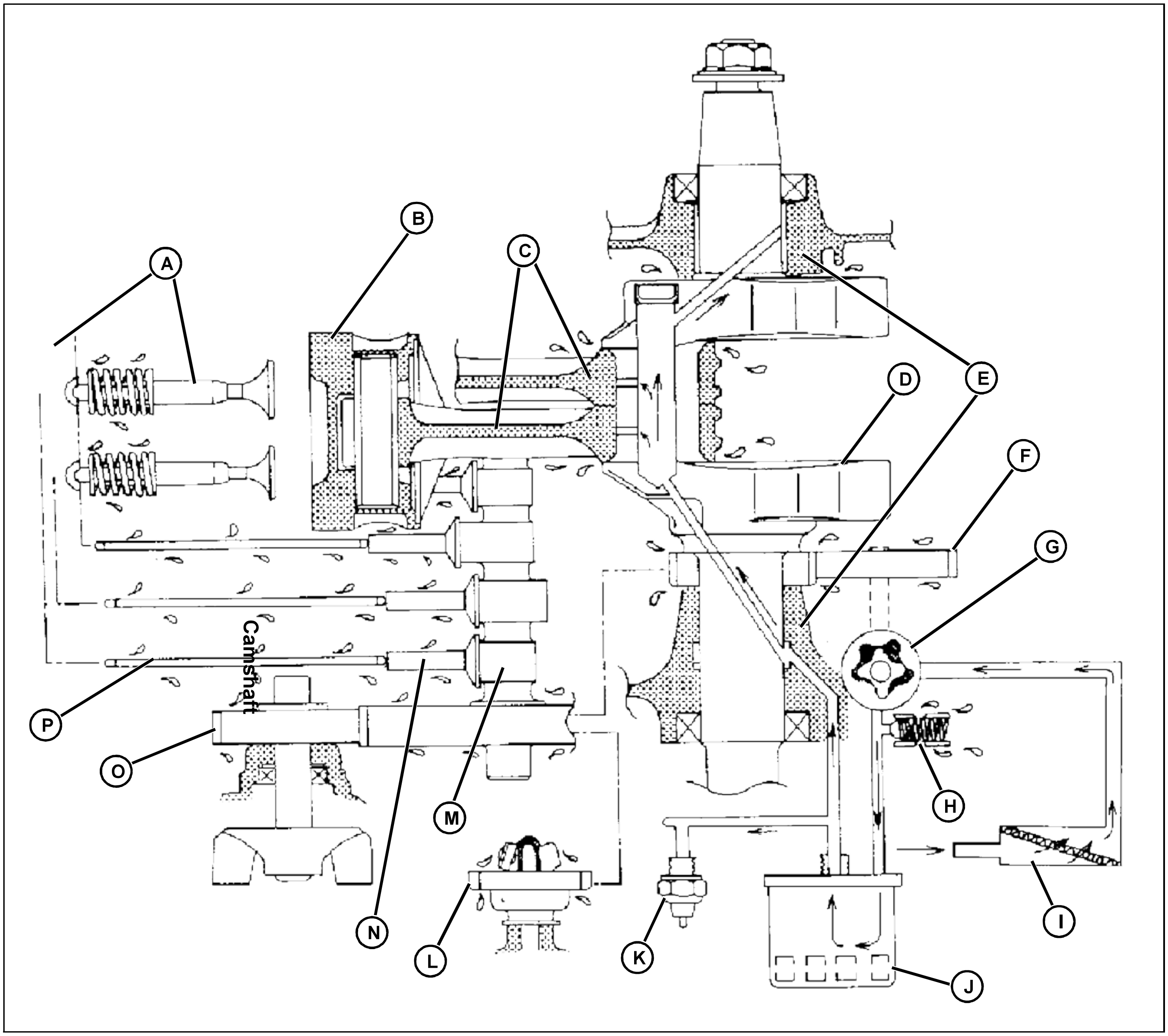
The oil pump draws oil from the sump through the pick-up screen. Pressure oil from the pump flows through the pump outlet passage past the oil pressure relief valve. The oil pressure relief valve limits the oil pressure to approximately 296 kPa (43 psi) and protects the oil pump from damage if an oil passage becomes blocked. If the oil pressure exceeds 296 kPa (43 psi), the relief valve opens allowing oil to return to the sump. The relief valve is not adjustable.

Pressure oil flows past the relief valve to the oil filter. The filter contains a bypass valve which opens at 78.5 - 117.5 kPa (11.4 - 17.1 psi) if the element becomes plugged to ensure engine lubrication.

An oil pressure switch mounted above the oil filter turns on a warning light if oil pressure is below 98 kPa (14.2 psi). Filtered pressure oil flows through a passage in the oil sump to the crankshaft main bearing (PTO side). Drilled passages in the crankshaft distribute oil from the main bearings to the connecting rod journals and crankshaft main bearings (flywheel side). A drilled passage in the connecting rods allows oil from the connecting rod journal to lubricate the piston and cylinder walls.

In the cylinder head, the rocker arms, valves, and pushrods are lubricated by an oil/air mixture carried through an upper lubrication passage from the breather chamber. As this oil/air mixture is swirled around the rocker arm chamber, the oil particles cling to the moving parts, lubricating them. Eventually these oil particles collect into a liquid state again in the lower portion of the rocker arm chamber. A small return passage is provided to return this liquid state oil back into the crankcase.

The camshaft gear, camshaft, tappets, coolant pump gear, governor gear, oil pump gear, and crankshaft gear are lubricated by oil splash generated by the internal moving parts during operation.



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Top View

- **A - Rocker Arms and Valves**
- **B - Pistons**
- **C - Connecting Rods**
- **D - Crankshaft**
- **E - Crankshaft Main Bearings**
- **F - Oil Pump Gear**
- **G - Oil Pump**
- **H - Oil Pressure Relief Valve**
- **I - Pick-up Screen**
- **J - Oil Filter**
- **K - Oil Pressure Sensor**
- **L - Governor Gear**
- **M - Camshaft**
- **N - Tappets**
- **O - Coolant Pump Gear**
- **P - Push Rods**

Cooling System Operation

Function:

Remove heat from engine.

Theory of Operation:

The engine is liquid-cooled and uses a pressurized, fin-type radiator, fan, coolant pump, and thermostat to regulate engine temperature. The cooling system is protected by a coolant temperature switch that activates a warning light on the dash if the engine temperature reaches 107 - 113° C (225 - 235° F). The coolant pump is driven by the camshaft gear.

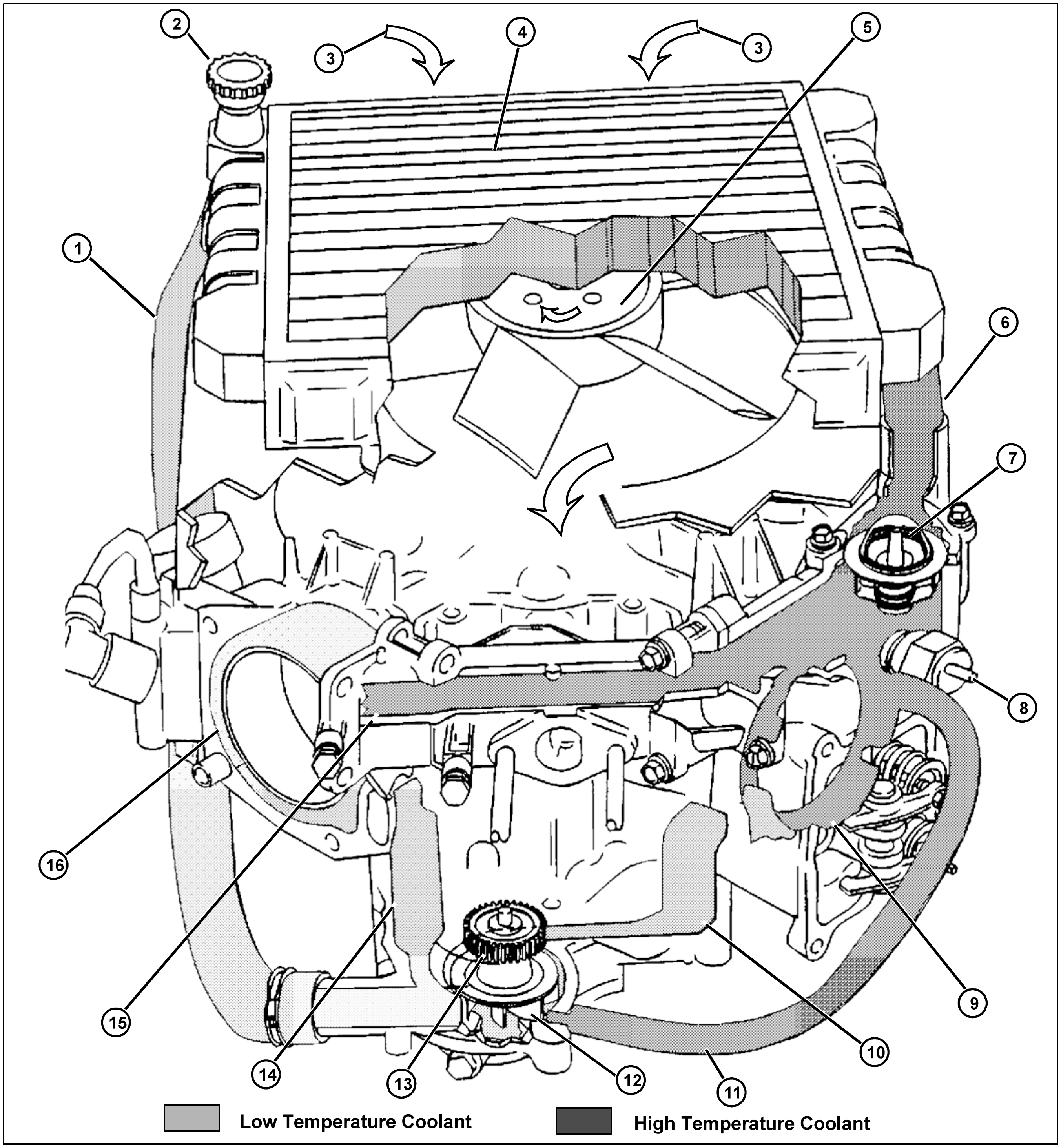
When the engine temperature is below 82° C (180° F), the thermostat is closed. When the thermostat is closed coolant flow into the radiator is stopped. The coolant pump must now draw coolant from the bypass hose which is between the cylinder head and coolant pump. The impeller forces the low temperature coolant through the cylinder block coolant passage to the piston coolant passage. Coolant flows around the piston coolant passage, and then through the right cylinder head, intake manifold, and left cylinder head to the bypass hose. The engine heat is transferred to the coolant and the coolant temperature increases. Since the high temperature coolant bypasses the radiator, the engine warms up to operating temperature quickly.

When the coolant temperature reaches 82° C (180° F), the thermostat begins to open and is fully open at 95° C (203° F). High temperature coolant from the left cylinder head flows through the thermostat to the radiator. The radiator is cooled by a radiator fan that is mounted to the flywheel. The radiator fan pulls air in from the top of the engine and downward through the radiator fins. The coolant temperature decreases as the coolant pump forces coolant into the radiator inlet and through the cooling fins to the radiator outlet.

With the thermostat open, the coolant pump draws low temperature coolant from the radiator through the radiator outlet hose instead of the bypass hose. The low temperature coolant is circulated through the engine to provide constant cooling.

A coolant temperature switch mounted in the left cylinder head activates a warning light on the dash if the coolant temperature should reach 107 - 113° C (225 - 235° F).

The radiator cap should maintain a constant pressure of 88 kPa (13 psi) inside the radiator which actually raises the boiling point of the coolant. The radiator cap contains a pressure valve and vacuum valve. When the coolant is hot and pressure is above 90 kPa (13 psi), the pressure valve opens allowing some coolant to flow to the overflow reservoir. After the engine has stopped, the coolant cools and the pressure inside the radiator decreases to create a partial vacuum. When vacuum pressure reaches 4.9 kPa (0.71 psi) the vacuum valve opens and some coolant flows from the overflow reservoir into the radiator, keeping it full.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▨ Low Temperature Coolant
■ High Temperature Coolant

M44227

- A - Outlet Hose
- B - Radiator Cap
- C - Air Flow
- D - Radiator
- E - Fan
- F - Inlet Hose
- G - Thermostat
- H - Coolant Temperature Switch
- I - Cylinder Head Coolant Passage
- J - Cylinder Block Coolant Passage
- K - Bypass Hose
- L - Impeller
- M - Coolant Pump Gear
- N - Cylinder Block Coolant Passage
- O - Intake Manifold Coolant Passage
- P - Piston Coolant Passage

Diagnostics

Engine Diagnosis

CAUTION: Avoid Injury! Engine radiator fluid is extremely hot during operation. The engine may start to rotate at any time. Keep hands away from all moving parts when testing.

Symptom: Engine Starting Problems

(1) Engine will not crank?

Yes - Battery weak or discharged.

Yes - Fusible link defective

Yes - Check key switch or wiring.

Yes - Starter solenoid defective.

Yes - Starter motor defective.

No - Go to next step.

(2) Engine cranks but will not start?

No - Go to next step.

Yes - Battery weak or discharged.

Yes - Fuel shut-off valve closed (in-line valve).

Yes - Fuel shut-off solenoid not allowing fuel into main jet.

Yes - Improper use of choke.

Yes - Float level too high.

Yes - Check spark. See “Spark Plug Gap Adjustment” on page 150.

Yes - Weak or faulty spark plug.

Yes - Faulty high tension leads.

Yes - Faulty ignition module.

Yes - Faulty ignition coil.

Yes - Faulty pulsar coil.

Yes - Contaminated fuel or faulty fuel supply system.

Yes - Defective fuel pump.

Yes - Air being drawn in through a hole in fuel line(s).

Yes - Clogged fuel line or filter.

Yes - Fuel tank vent line clogged.

Yes - Air filter restricted.

Yes - Defective head gasket.

Yes - Cylinder head loose.

Symptom: Engine Starting Problems

Yes - Broken valve spring.

Yes - Warped cylinder head.

Yes - Poor compression. Worn piston/piston rings stuck or not seated. Worn cylinder bore.

Yes - Worn or burned valves, or improper clearance.

(3) Engine will not start; plug wet?

No - Go to next step.

Yes - Mixture too rich.

Yes - Clean under engine shrouding.

Yes - Check spark plug gap and spark. See “Spark Plug Gap Adjustment” on page 150 and “Spark Test” on page 150.

Yes - Inlet needle and seat sticking.

Yes - Clean carburetor.

(4) Engine is hard to start when cold?

No - For additional tests, see “Engine Tests” on page 140.

Yes - Mixture too rich.

Yes - Mixture too lean.

Yes - Clean under engine shrouding.

Yes - Choke is not completely shut. Adjust.

Yes - Inlet needle and seat sticking.

Yes - Clean carburetor.

Symptom: Engine Performance Problems

(1) Loss of power?

No - Go to next step.

Yes - Low oil level.

Yes - Too much oil in crankcase.

Yes - Carburetor out of adjustment.

Yes - Air/Fuel passages plugged.

Yes - Carbon deposits in exhaust pipe/muffler.

Yes - Carbon deposits in combustion chamber.

Yes - Weak or faulty spark plug.

Yes - Faulty high tension leads.

Yes - Faulty ignition module.

Yes - Faulty ignition coil.

Yes - Faulty pulsar coil.

Symptom: Engine Performance Problems

Yes - Contaminated fuel or faulty fuel supply system.

Yes - Defective fuel pump.

Yes - Air being drawn in through a hole in fuel line(s).

Yes - Clogged fuel line or filter.

Yes - Fuel tank vent line clogged.

Yes - Vapor lock.

Yes - Air filter restricted.

Yes - Defective breather valve.

Yes - Cylinder head loose.

Yes - Mixture too lean.

Yes - Check and clean air cleaner.

Yes - Adjust idle mixture and check engine performance.

Yes - Choke is not completely open. Adjust.

Yes - Clean carburetor.

Yes - Worn or burned valves, or improper clearance.

Yes - Broken valve spring.

Yes - Warped cylinder head.

Yes - Defective head gasket.

Yes - Poor compression. Worn piston/piston rings stuck or not seated. Worn cylinder bore.

(2) Engine runs erratically?

No - Go to next step.

Yes - Carburetor out of adjustment.

Yes - Lack of coolant.

Yes - Governor linkage out of adjustment.

Yes - Faulty governor spring.

Yes - Governor gear assembly binding or broken.

Yes - Check spark. See “Spark Test” on page 150.

Yes - Carburetor flange loose or leaking at gasket.

Yes - Carburetor body and throttle shaft worn.

Yes - Weak or faulty spark plug.

Yes - Faulty high tension leads.

Yes - Faulty ignition module.

Yes - Faulty ignition coil.

Yes - Faulty pulsar coil.

Yes - Contaminated fuel or faulty fuel supply system.

Symptom: Engine Performance Problems

Yes - Defective fuel pump.

Yes - Air being drawn in through a hole in fuel line(s).

Yes - Clogged fuel line or filter.

Yes - Fuel tank vent line clogged.

Yes - Vapor lock.

Yes - Oil leakage around governor shaft.

Yes - Defective oil seal.

(3) Engine misses at high rpm?

No - Go to next step.

Yes - Check spark. See “Spark Test” on page 150.

Yes - Weak or faulty spark plug.

Yes - Faulty high tension leads.

Yes - Faulty ignition module.

Yes - Faulty ignition coil.

Yes - Faulty pulsar coil.

Yes - Carburetor out of adjustment.

Yes - Clogged fuel line or filter.

Yes - Fuel tank vent line clogged.

Yes - Defective fuel pump.

Yes - Warped cylinder head.

(4) Engine misses at low rpm?

No - Go to next step.

Yes - Carburetor out of adjustment.

Yes - Air/Fuel passages plugged.

Yes - Air being drawn through carburetor or intake manifold flanges.

Yes - Incorrect timing gear alignment.

Yes - Check spark. See “Spark Test” on page 150.

Yes - Weak or faulty spark plug.

Yes - Faulty high tension leads.

Yes - Faulty ignition module.

Yes - Faulty ignition coil.

Yes - Faulty pulsar coil.

Yes - Worn or burned valves, or improper clearance.

Yes - Warped cylinder head.

(5) Engine rpm low or engine stalls?

Symptom: Engine Performance Problems

No - Go to next step.

Yes - Battery weak or discharged.

(6) Engine speed unstable (surging)?

No - Go to next step.

Yes - Mixture too lean.

Yes - Clean under engine shrouding.

Yes - Adjust idle mixture and check engine performance.

Yes - Clean carburetor.

(7) Engine is sluggish?

No - Go to next step.

Yes - Mixture too rich.

Yes - Check and clean air cleaner.

Yes - Adjust idle mixture and check engine performance.

Yes - Choke is not completely open. Adjust.

Yes - Clean carburetor.

(8) Black, smoky exhaust?

No - Go to next step.

Yes - Check spark plug gap and spark. See “Spark Plug Gap Adjustment” on page 150 and “Spark Test” on page 150.

Yes - Mixture too rich.

Yes - Check and clean air cleaner.

Yes - Choke is not completely open. Adjust.

(9) Spark plug fouled black?

No - Go to next step.

Yes - Check spark plug gap and spark. See “Spark Plug Gap Adjustment” on page 150 and “Spark Test” on page 150.

Yes - Mixture too rich.

Yes - Check and clean air cleaner.

Yes - Adjust idle mixture and check engine performance.

Yes - Choke is not completely open. Adjust.

Yes - Inlet needle and seat sticking.

(10) Spark plug burned white?

No - Go to next step.

Symptom: Engine Performance Problems

Yes - Check spark plug gap and spark. See “Spark Plug Gap Adjustment” on page 150 and “Spark Test” on page 150.

Yes - Mixture too lean.

Yes - Clean under engine shrouding.

Yes - Clean carburetor.

(11) Runs better without air cleaner?

No - Go to next step.

Yes - Mixture too rich.

Yes - Check and clean air cleaner.

(12) Runs worse when warm?

No - Go to next step.

Yes - Mixture too rich.

Yes - Check and clean air cleaner.

Yes - Adjust idle mixture and check engine performance.

Yes - Choke is not completely open. Adjust.

Yes - Inlet needle and seat sticking.

(13) Engine overheats?

No - Go to next step.

Yes - Mixture too lean.

Yes - Clean under engine shrouding.

Yes - Water pump nylon impeller defective.

(14) Engine backfires?

No - Go to next step.

Yes - Carburetor out of adjustment.

Yes - Check spark. See “Spark Test” on page 150.

Yes - Faulty pulsar coil.

Yes - Air being drawn in through a hole in fuel line(s).

Yes - Cylinder head loose.

Yes - Warped cylinder head.

Yes - Defective head gasket.

Yes - Intake valve burned or sticking.

(15) Engine knocks?

No - Go to next step.

Yes - Excessive engine load.

Yes - Faulty ignition module.

Symptom: Engine Performance Problems

Yes - Contaminated fuel or faulty fuel supply system.

Yes - Defective head gasket.

(16) Engine overheats?

No - For additional tests, see "Engine Tests" on page 140.

Yes - Lack of coolant.

Yes - Excessive engine load.

Yes - Fan belt slippage.

Yes - Defective radiator hose or clamp.

Yes - Improper or defective radiator cap.

Yes - Broken or missing fan shroud.

Yes - Defective radiator.

Yes - Loose stud bolts and cap screw.

Yes - Cracked or porous casting.

Yes - Damaged water pump seals.

Yes - Improperly installed gasket.

Yes - Warped cylinder head.

Yes - Broken valve spring.

Yes - Defective head gasket.

Yes - Worn or burned valves, or improper clearance.

Symptom: Engine fuel/oil/coolant problems

(1) Excessive fuel consumption?

No - Go to next step.

Yes - Check spark (See Electrical section).

Yes - Weak or faulty spark plug.

Yes - Faulty high tension leads.

Yes - Faulty ignition module.

Yes - Faulty ignition coil.

Yes - Faulty pulsar coil.

Yes - Improper use of choke.

Yes - Air filter restricted.

Yes - Carburetor out of adjustment.

Yes - Float level too high.

Yes - Cylinder head loose.

Yes - Broken valve spring.

Yes - Worn or burned valves, or improper clearance.

Symptom: Engine fuel/oil/coolant problems

Yes - Poor compression. Worn piston/piston rings stuck or not seated. Worn cylinder bore.

(2) Excessive oil consumption?

No - Go to next step.

Yes - Too much oil in crankcase.

Yes - Incorrect oil viscosity.

Yes - Drain-back in breather chamber plugged.

Yes - Defective breather valve.

Yes - Worn valve stems(s) or valve guide(s).

Yes - Plugged oil ring groove.

Yes - Poor compression. Worn piston/piston rings stuck or not seated. Worn cylinder bore.

(3) Coolant leakage?

No - For additional tests, see "Engine Tests" on page 140.

Yes - Lack of coolant.

Yes - Improper or defective radiator cap.

Yes - Defective radiator hose or clamp.

Yes - Defective radiator.

Yes - Cracked or porous casting.

Yes - Loose stud bolts and cap screw.

Yes - Engine overheating.

Yes - Damaged water pump seals.

Yes - Improperly installed gasket.

Yes - Cylinder head loose.

Engine Tests

Test Conditions:

- Machine parked on level surface.
- PTO Switch off
- Key switch off unless indicated otherwise.
- Spark plug connected to D-05351ST Spark Tester

System: Engine

(1) When checking dipstick, oil at proper level and viscosity? No leakage? Clean oil and filter?

Yes - Go to next step.

System: Engine

No - Change oil and inspect for source of contamination.

No - Change oil filter.

No - Check gaskets, seals, plugs, cylinder head, block, and intake manifold and breather.

(2) Air filter outlet hose not cracked; clamps tight?

Yes - Go to next step.

No - Replace hose and/or tighten clamps.

(3) Air filter elements not plugged? Air filter housing sealed; no dirt tracking inside filter element?

Yes - Go to next step.

No - Replace element or housing.

(4) Air filter restriction indicator not leaking?

Yes - Go to next step.

No - Replace indicator.

(5) Does fuel shutoff solenoid pull in and stay in when key is returned to "ON"? (Listen for clicking as key is cycled.)

Yes - Go to next step.

No - If solenoid will not pull in and hold in, see "Fuel Shutoff Solenoid Circuit Diagnosis" on page 322 in Electrical section.

(6) Check hand throttle control lever linkage. Full movement of governor control arm from idle to full speed?

Yes - Go to next step.

No - Repair; replace or adjust linkage.

(7) Check intake and exhaust valves. Valve clearance within specification (engine cold)? Valves not sticking?

Yes - Go to next step.

No - Adjust valves. See "Valve Clearance Test and Adjustment" on page 146.

No - Check valve guides and stems.

(8) Check flywheel and starting motor: Minimum cranking rpm within specification?

Yes - Go to next step.

No - See "Starter Loaded Amperage Draw Test" on page 335 in Electrical section.

System: Engine

(9) Carburetor choke and governor linkage. Linkage not binding and adjusted correctly?

Yes - Go to next step.

No - Repair, replace or adjust linkage.

(10) Carburetor - fuel filter, fuel pump, and carburetor bowl drain screw (key switch on). Fuel level increases in filter? Fuel pump operating - listen for humming sound near fuel cap? Fuel present in float bowl when screw is opened?

Yes - Go to next step.

No - See "Fuel Shutoff Solenoid Circuit Diagnosis" on page 322 in the Electrical section.

No - Test fuel pump pressure and flow.

No - Check carburetor for debris.

(11) Carburetor/Throttle body (engine running). Low idle at 1550 rpm? High idle at 3550 rpm?

Yes - Go to next step.

No - See "Slow Idle Speed Adjustment" on page 145 and "Fast Idle Speed Adjustment" on page 144 in this section.

(12) Engine runs smoothly through out rpm range with low smoke and good power?

Yes - Go to next step.

No - Adjust governor.

(13) Test oil pressure switch port. Minimum oil pressure within specifications?

Yes - Go to next step.

No - Test engine oil pressure. See "Engine Oil Pressure Test" on page 148.

(14) Thermostat opening temperature within specifications?

Yes - Go to next step.

No - Perform thermostat opening test. See "Thermostat" on page 160.

(15) Muffler not restricted?

Yes - Go to next step.

No - Replace muffler.

(16) When performing cylinder compression test: Cylinder compression within specification? Pressure difference between cylinders within specification?

Yes - Engine tests completed.

System: Engine

No - Rebuild engine.

System: Coolant tank and radiator

(1) Coolant level between marks on tank when engine is warm? Coolant in radiator full to top?

Yes - Go to next step.

No - Add proper coolant mix.

(2) Coolant not contaminated with oil, fuel or discolored brown?

Yes - Go to next step

No - Drain and flush system. Check for source of contamination.

(3) Radiator screen free of debris?

Yes - Go to next step.

No - Clean or replace.

(4) Hoses not cracked or leaking; clamps and radiator cap tight?

Yes - Go to next step.

No - Pressure test radiator and cap.

(5) Water pump/alternator belt tight; not glazed or cracked?

Yes - Go to next step.

No - Replace and adjust belt tension.

(6) Fan blades not damaged or warped?

Yes - Coolant tests completed.

No - Replace fan.

System: Fuel tank, pump, lines and filter

(1) Fuel level correct; not contaminated or stale smelling; no water in fuel?

Yes - Go to next step.

No - Drain and clean fuel tank. Add fresh fuel.

(2) Fuel pump filter and in-line filter free of debris?

Yes - Go to next step.

No - Replace filters.

(3) Fuel hoses not cracked or leaking?

Yes - Go to next step.

No - Replace.

(4) Fuel hose clamps tight?

System: Fuel tank, pump, lines and filter

Yes - Go to next step.

No - Replace or tighten.

(5) Fuel tank does not have vacuum?

Yes - Fuel tank, pump, lines and filter tests completed.

No - Replace vented fuel cap.

Tests and Adjustments

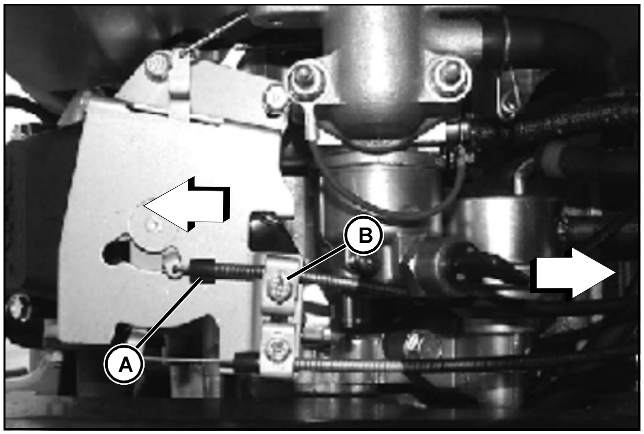
Throttle Cable Test and Adjustment

Reason:

To make sure throttle cable has all slack removed and obtains full range of travel, and control lever contacts the slow idle stop at slow idle position.

Test Procedure:

1. Park machine on a flat surface. Turn engine OFF, and lock parking brake.
2. Remove engine hood. See “Hood Removal and Installation” on page 589 in the Miscellaneous section.
3. Move throttle control lever to SLOW idle position.



M99726

4. Loosen clamp screw (B) securing throttle cable (A). Pull throttle cable housing to remove any slack from the throttle cable. Tighten clamp screw.
5. Move throttle control lever into FAST idle position. Ensure full range of motion of throttle cable and throttle arm.

Results:

- If full range of motion is obtained, throttle cable is adjusted properly.
- If full range of motion is not obtained, perform Adjustment Procedure.

Adjustment Procedure:

1. Move throttle control lever to FAST idle position.
2. Loosen clamp screw.
3. Pull throttle cable toward carburetor (arrow) and tighten screw.
4. Repeat CHECK procedure.
5. Move throttle control lever through full range to be sure linkage is not binding.
6. Move throttle lever to the slow idle position. Be sure the throttle valve tab on the carburetor contacts the slow idle stop screw before the throttle lever bottoms out. See “Slow Idle Speed Adjustment” on page 145.

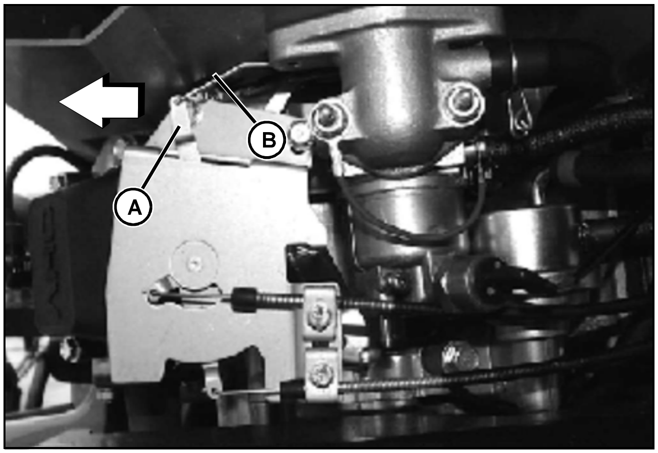
Choke Cable Test and Adjustment

Reason:

To make sure that the choke plate is fully closed when the throttle control lever is in the full choke position and does not stay partially closed when the throttle control lever is in the fast idle position.

Test Procedure:

1. Park machine on a flat surface. Turn engine OFF, and lock parking brake.
2. Remove engine hood. See “Hood Removal and Installation” on page 589 in the Miscellaneous section.
3. Move choke control lever to full CHOKE position.



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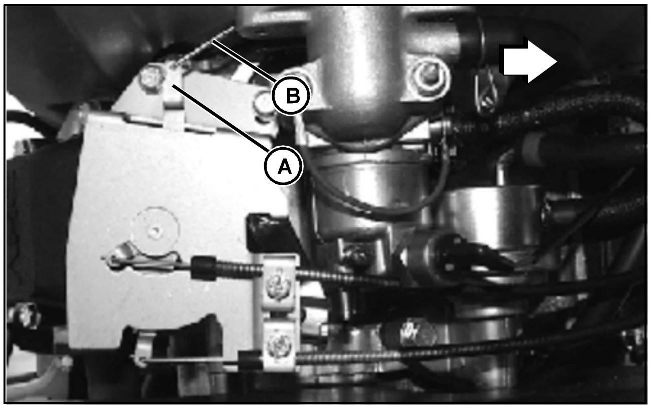
4. Loosen clamp screw securing choke cable.
5. Try to move choke rod (B) away from carburetor (arrow). Choke rod should NOT move. If choke rod moves to the left, the choke plate is NOT fully closed.
6. Tighten clamp screw.
7. Move choke control lever (A) to the OFF position.



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8. Try to move choke rod (B) toward carburetor (arrow). Choke rod should not move. If choke rod moves to the right, the choke plate is not fully open.

Results:

- If choke rod DOES NOT move in either direction with the choke control lever (A) in the specific positions, choke operation is functioning properly.
- If choke rod MOVES in either direction with throttle control lever in the specific positions, perform Adjustment Procedure.

Governor Adjustment

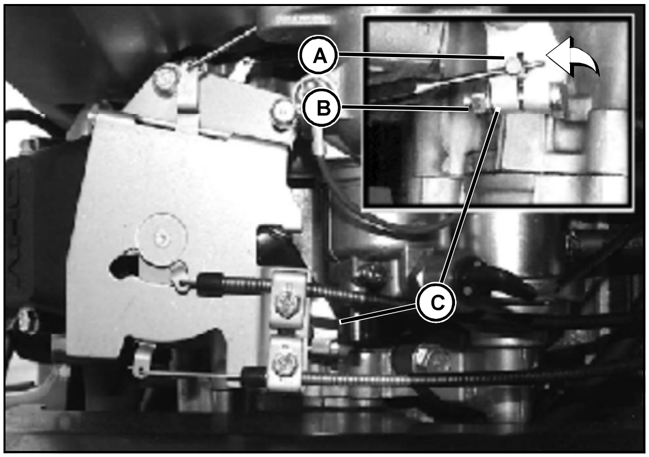
Reason:

To ensure proper operation of the governor.

Procedure:

NOTE: Adjust throttle cable and choke plate before adjusting governor linkage.

1. Adjust throttle cable and choke plate.
2. Move throttle lever to FAST idle position.



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3. Loosen nut.
4. Hold governor arm (C) fully counterclockwise.
5. Using a small pin, rotate shaft counterclockwise as far as it will go. Hold governor shaft (A) and tighten nut (B) to 7.8 N•m (69 lb-in.).
6. Move throttle lever through full range to be sure linkage is not binding.

Fast Idle Speed Adjustment

Reason:

To set engine fast idle speed.

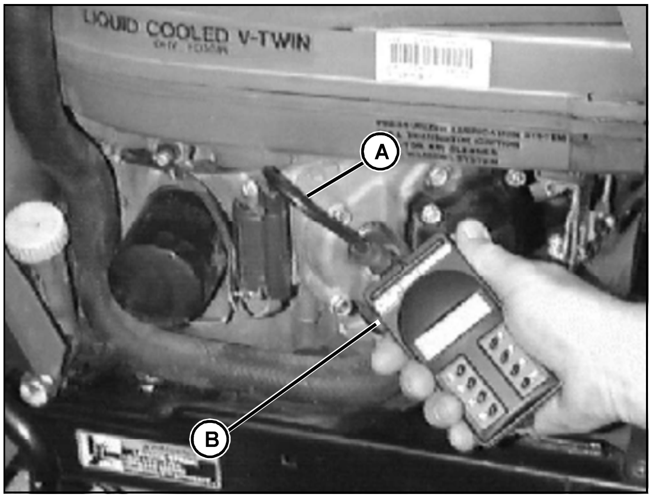
Equipment:

- JT07270 Digital Pulse Tachometer; or,
- JT05719 Photo Tachometer

Procedure:

1. Park machine on level surface.
2. Turn key switch OFF.
3. Remove engine hood. See “Hood Removal and Installation” on page 589 in the Miscellaneous section.
4. Start and run engine at MEDIUM idle for 5 minutes.

⚠ **CAUTION: Avoid injury! Engine will be HOT. Be careful not to burn hands.**



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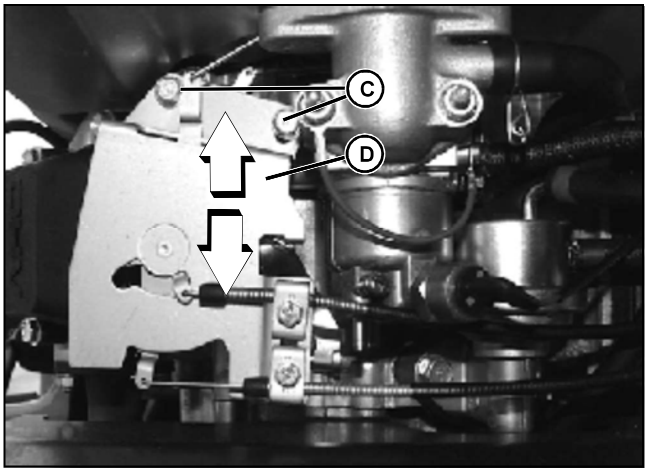
5. Use JT07270 Digital Pulse Tachometer (B) at spark plug wire (A).



M99726

6. Loosen cap screws (C) securing throttle control panel (D).

7. Move the right side of the control panel up or down to adjust engine rpm using JT07270 Digital Pulse Tachometer.

Specifications:

Fast Idle Speed Setting . . . . .3550 ± 50 rpm

Results:

If fast idle speed does not meet specifications:

- Loosen cap screws.
- Move throttle control panel away from carburetor to increase rpm or toward carburetor to decrease rpm.
- Hold throttle control panel and tighten cap screws.

Slow Idle Speed Adjustment

CAUTION: Avoid Injury! DO NOT attempt to adjust the carburetor unless you are a factory trained technician with authorization to service CARB/EPA Certified Emissions Carburetors.

Reason:

To properly adjust engine SLOW idle mixture and rpm speed settings. This insures that engines with CARB/EPA Certified Emissions Carburetors meet the CARB/EPA emissions requirements.

Equipment:

- JT07270 Digital Pulse Tachometer

Procedure:

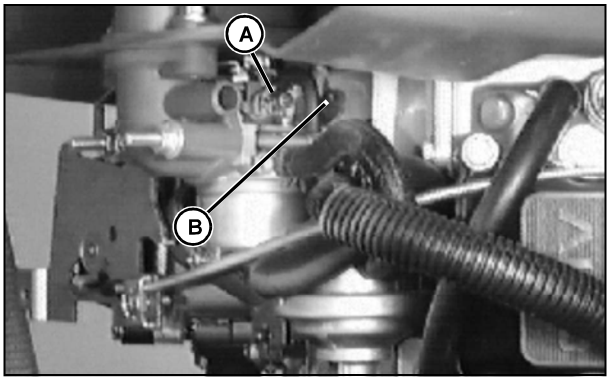
Slow engine rpm is governed and normally will not need to be adjusted. The mixture screw is factory set and should not need to be adjusted. The limiter cap should not be removed unless you are a factory trained to service CARB/EPA carburetors.

1. Park machine on level surface.

2. Turn key switch OFF.

3. Remove engine hood. See “Hood Removal and Installation” on page 589 in the Miscellaneous section.

NOTE: Breather assembly and fuel line removed for clarity only. DO NOT remove for adjustment.



M85630

4. Start and run engine at MEDIUM idle for five minutes to obtain normal operating temperature.

5. Move throttle control lever to SLOW idle position.

6. Use JT07270 Digital Pulse Tachometer at spark plug wire to adjust carburetor SLOW idle stop screw (A) until SLOW idle speed is set at 1400 rpm to remove governor action.

7. Turn SLOW idle mixture screw (B) clockwise until engine speed drops, note position.

8. Then turn screw counterclockwise until it increases and drops again, note position.

9. Turn screw clockwise again to midway between drop points.

10. Use JT07270 Digital Pulse Tachometer at spark plug wire to adjust SLOW idle mixture screw to a SLOW idle speed setting of 1450 ± 50 rpm.

11. Turn carburetor SLOW idle stop screw to a SLOW idle speed setting of 1550 ± 150 rpm (100 rpm higher than SLOW idle mixture screw).

12. Install engine hood.

Cylinder Compression Pressure Test

Reason:

To determine the condition of the pistons, rings, cylinder walls, gasket, and valves.

NOTE: Unlike single cylinder engines, these two engines DO NOT have an ACR mechanism; therefore, this test will indicate actual compression readings.

Test Equipment:

- JDM59 Compression Gauge

Procedure:

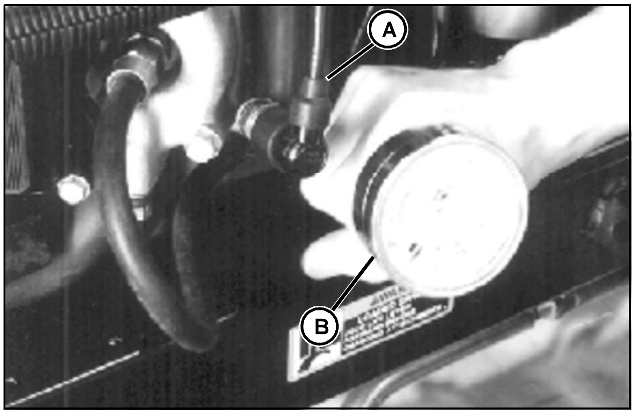
1. Park machine on level surface.
2. Turn key switch OFF.
3. Move forward/reverse pedals to NEUTRAL position.
4. Lock park brake.
5. Raise or remove engine hood.

IMPORTANT: Avoid damage! Proper valve adjustment is essential to obtain an accurate compression reading. Before performing cylinder compression pressure test, verify valve clearances while engine is cold 15 - 30° C (60 - 85° F).

6. Verify valve clearances. See “Valve Clearance Test and Adjustment” on page 146.
7. Run engine for 5 minutes to bring engine to operating temperature.

CAUTION: Avoid injury! Engine will be HOT. Be careful not to burn hands.

8. Remove both spark plugs.



M83429

9. Install JDM59 Compression Gauge (B) in one spark plug hole.
10. To protect ignition system, ground both spark plug wires (A) or disconnect positive lead from both ignition coils.
11. Move throttle control lever to FAST idle position - carburetor throttle and choke plates must be fully open to obtain an accurate reading.

IMPORTANT: Avoid damage! DO NOT overheat starting motor during test. Starting motor duty cycle is 5 seconds ON, 10 seconds OFF. Battery must be at a full state of charge - charge battery first, if necessary.

12. Crank engine until gauge needle settles out at its highest position.
13. Record pressure reading.
14. Repeat test for other cylinder and compare readings to specifications.

Specifications:

Minimum Compression . . . . 1171 kPa (170 psi)
Maximum Difference between Cylinders . . . . 97 kPa (14 psi)

Results:

NOTE: Above specifications are for an engine that has had sufficient time to allow rings to fully seat.

Compression that is lower than specifications on low hour machines (but relatively equal on both cylinders) does not indicate a problem.

- If compression reading is below minimum specification, squirt clean engine oil into cylinder and repeat test.
- If after retest compression pressure DOES NOT increase - check for leaking intake or exhaust valves, valve seats, or cylinder head gaskets. Replace parts as necessary.
- If after retest compression pressure INCREASES more than 138 kPa (20 psi) - check rings, pistons, and cylinder bores for broken rings, scoring, excessive wear, or other damage. Replace parts as necessary.

Valve Clearance Test and Adjustment

Reason:

To ensure proper opening and closing of the intake and exhaust valves.

Equipment:

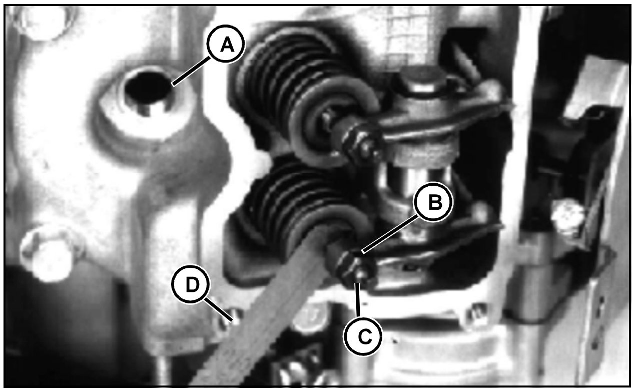
- Feeler Gauge (blade-type)

Procedure:

IMPORTANT: Avoid damage! Make adjustment when engine is cold 15 - 30° C (60 - 85° F).

NOTE: Check valve clearance for each cylinder separately.

1. Park machine on level surface.
2. Turn key switch OFF. Allow engine to cool.
3. Move forward/reverse pedals to NEUTRAL position.
4. Lock park brake.
5. Raise engine hood.
6. Remove spark plugs.
7. Remove valve covers.



M51715

8. Turn crankshaft until piston, visible in spark plug hole (A), is at Top Dead Center (TDC) of the compression stroke (both intake and exhaust valves will be closed).

9. Use a blade-type feeler gauge (D) to measure valve clearance. Valve clearance should be 0.15 mm (0.006 in.).

Specifications:

Valve Clearance (cold) . . . . 0.15 mm (0.006 in.)
Jam Nut Torque . . . . 9.0 N•m (79 lb-in.)
Valve Cover Cap Screw Torque. . . 6.0 N•m (53.0 lb-in.)
Spark Plug Torque . . . . 20 N•m (15 lb-ft)

Results:

- If valve clearance DOES NOT meet specifications, loosen the jam nut (B). Turn adjustment screw (C) to adjust valve clearance to specifications. Hold screw and tighten nut to specifications. Check clearance again.

Crankcase Vacuum Test

Reason:

To check operation of the breather and condition of seals, gaskets, rings, pistons, and cylinder walls.

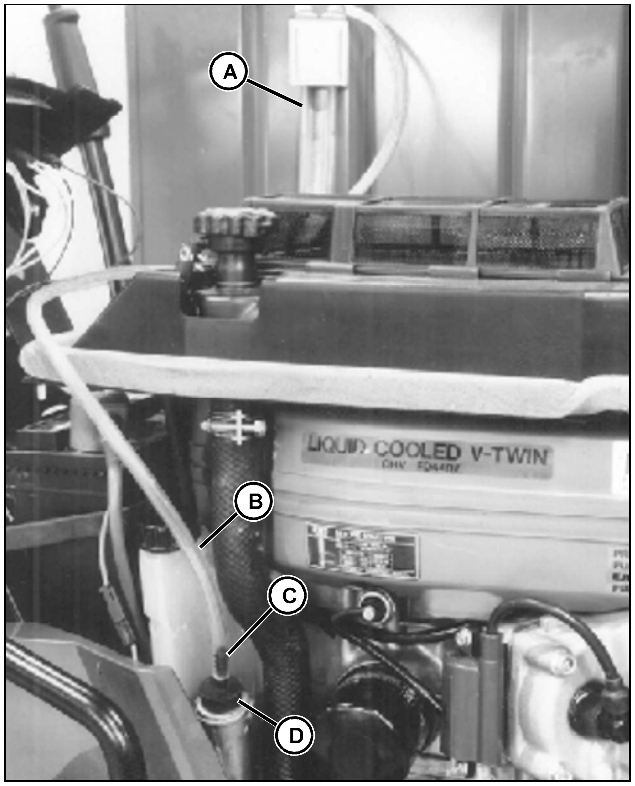
Test Equipment:

- JT05697 U-Tube Manometer Test Kit or
- JT03503 Crankcase Vacuum Test Kit

Procedure:

JT05697 U-Tube Manometer Test Kit -

1. Park machine on level surface.
2. Raise engine hood.



M83432

3. Remove dipstick and install appropriate size plug (D).

4. Insert large diameter end of barbed fitting (C) into clear line (B).

5. Insert other end of barbed fitting into plug in dipstick tube.

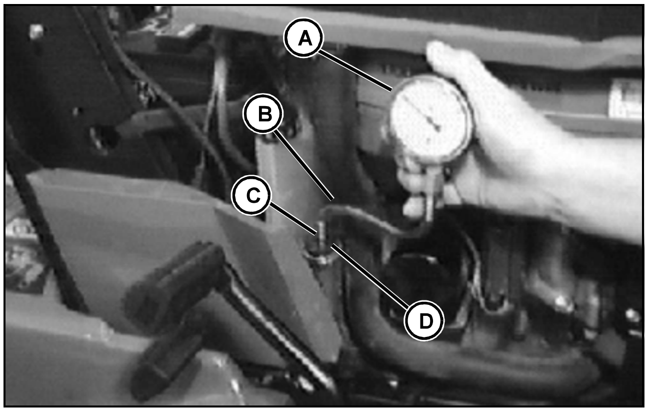
6. Align ruler “zero” markings with top of water level in U-tube (A).

IMPORTANT: Avoid damage! DO NOT make connection between U-Tube Manometer (A) and clear line BEFORE engine is running or fluid in manometer could be drawn into crankcase.

DO NOT turn engine OFF until line has been disconnected from Manometer.

7. Run engine at FAST idle.
8. Connect clear line to manometer.
9. Record crankcase vacuum reading. Manometer should show a minimum of 15 cm (6 in.) of water movement.
10. Run engine at SLOW idle. DO NOT TURN ENGINE OFF!
11. Disconnect line from Manometer.
12. Turn engine OFF.
13. Remove plug from dipstick tube and install dipstick.

JT03503 Crankcase Vacuum Test Kit -



M85638

1. Repeat Steps 1 - 3 in JT05697 test procedure.

IMPORTANT: Avoid damage! DO NOT make connection between test gauge and rubber plug BEFORE engine is running at FAST idle or gauge damage may result.

After test reading is made, disconnect test gauge WHILE engine is running at FAST idle to prevent damage to gauge.

2. Assemble gauge (A), clear line (B), and barbed fitting (C) on workbench.
3. Hold finger over rubber plug hole to keep oil from spraying out. Start engine and run at FAST idle.
4. Connect gauge, clear line, and barbed fitting to rubber plug (D).
5. Record crankcase vacuum reading. Gauge should show a minimum of 15 cm (6 in.) of vacuum.
6. Disconnect barbed fitting, clear line, and gauge from rubber plug WHILE engine is running at FAST idle. Hold finger over rubber plug hole to keep oil from spraying out.
7. Move throttle to SLOW idle and turn engine OFF.
8. Remove rubber plug and install dipstick.

Results:

If crankcase vacuum is BELOW specification, check the following:

- Breather reed valve clearance and condition.
- Breather port is obstructed.
- Rings, piston, and cylinder bore for wear or damage.

Engine Oil Pressure Test

Reason:

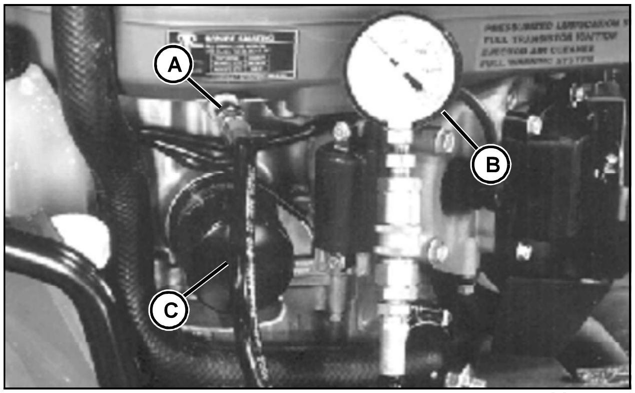
To verify if the engine has enough oil pressure to lubricate internal components.

Test Equipment:

- JT03344 Pressure Gauge Assembly
- JT03017 Hose Assembly
- JT03349 Connector

Procedure:

1. Park machine on level surface.
2. Turn key switch OFF. Allow engine to cool.
3. Move forward/reverse pedals to NEUTRAL position.
4. Lock park brake.
5. Raise engine hood.
6. Check engine oil level, bring level to full mark.
7. Disconnect oil pressure switch wiring lead.
8. Remove oil pressure switch.



M83430

9. Install JT03349 Connector (A).

10.Connect JT03017 Hose Assembly (C) and JT03344 Pressure Gauge Assembly (B).

11.Monitor oil pressure while cranking engine. If no oil pressure is present, discontinue cranking engine. Determine and correct cause before running engine.

IMPORTANT: Avoid damage! If pressure reading is below 69 kPa (10 psi), STOP ENGINE IMMEDIATELY and determine cause.

12.Start and run engine at Medium idle for five minutes to heat engine oil to normal operating temperature.

CAUTION: Avoid injury! Engine components are HOT. Be careful not to touch, especially the exhaust pipe or muffler while making adjustments. Wear protective eye glasses and clothing.

13.Run engine at FAST idle (3550 ± 50 rpm) and check oil pressure. Gauge should read a minimum oil pressure of 276 kPa (40 psi).

Results:

If oil pressure is BELOW specifications, inspect or replace the following:

- Oil pressure relief valve for broken or worn spring.
- Oil pressure relief valve for stuck or damaged valve.
- Worn or damaged oil pump.
- Oil filter plugged.
- Oil pump suction screen or oil passages plugged.
- Excessive wear of connecting rod and main bearing journals.

Fuel Pump Tests

Reason:

To check condition of fuel pump.

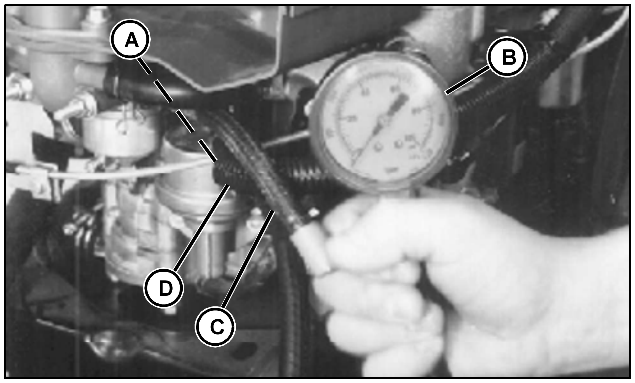
Test Equipment:

- JDG356 Pressure Gauge
- Graduated Container

Procedure:

1. Park machine on level surface.
2. Move forward/reverse pedals to NEUTRAL position.
3. Lock park brake.
4. Remove engine hood. See “Hood Removal and Installation” on page 589 in the Miscellaneous section.
5. Remove muffler heat shield.
6. Start engine and run at SLOW idle (1550 ± 150 rpm) for one minute to fill carburetor with fuel.
7. Stop the engine.

CAUTION: Avoid injury! Gasoline is extremely flammable. Do not smoke. Always work in a ventilated area away from open flame or spark producing equipment; including equipment that utilizes pilot lights. Wipe-up any spills IMMEDIATELY.



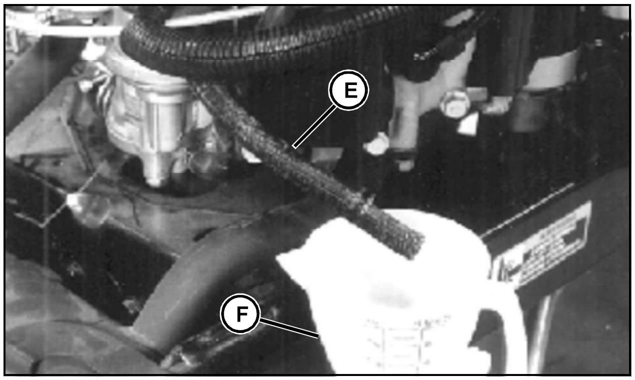
M83431

8. Disconnect fuel pump outlet hose (C) from fuel pump.

9. Connect JDG356 Pressure Gauge (B) hose (D) to fuel pump outlet (A).

10.Start and run engine at SLOW idle (1550 ± 150 rpm) for 15 seconds. Minimum pressure should be 2.45 kPa (0.36 psi).

11.Stop engine and remove pressure gauge and connect fuel pump outlet hose to fuel pump outlet.



M83433

12.Disconnect fuel pump outlet hose (E) from carburetor and place it in graduated container (F).

13.Start and run engine at SLOW idle (1550 ± 150 rpm) for 60 seconds, then stop engine and record container measurement. Minimum Flow should be 800 mL/60 seconds (0.8 qt/60 seconds).

Results:

If fuel pressure and/or flow does not meet specifications, check the following:

- Fuel lines, filter, shut-off valve, and fuel tank cap for restrictions.
- Replace fuel pump.
- Check camshaft lobe and retest.

Spark Test

Reason:

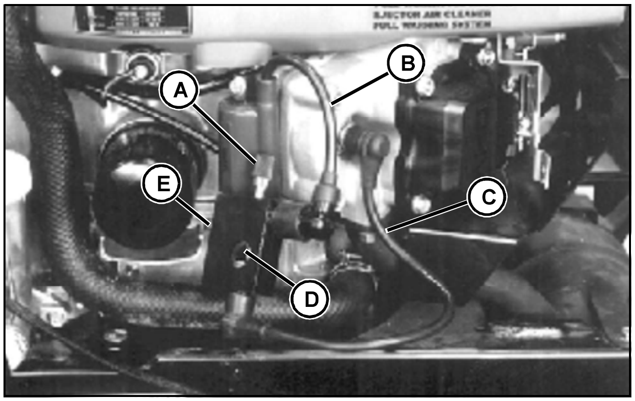
To check overall condition of ignition system.

Test Equipment:

- D-05351ST Spark Tester

Procedure:

1. Park machine on level surface.
2. Turn key switch OFF.
3. Move forward/reverse pedals to NEUTRAL position.
4. Lock park brake.
5. Disengage PTO.
6. Raise engine hood.



M83406

7. Disconnect high tension lead (B) from spark plug.
8. Connect D-05351ST Spark Tester (E) lead (C) to spark plug.
9. Connect high tension lead to Spark Tester.

IMPORTANT: Avoid damage! DO NOT adjust Spark Tester gap beyond 5.0 mm (0.200 in.) (5 turns), as damage to ignition components could occur.

10. Adjust spark tester gap to 4.2 mm (0.166 in.) (4 turns) with adjustment screw (A).
11. Move key switch to RUN position.
12. Spin engine with starter and watch spark at Spark Tester. If engine will start, watch spark (D) with engine running. A steady, strong, blue spark should be observed.

Results:

- If spark is weak, or no spark is present, install a new spark plug and repeat test.
- If spark is still weak, or no spark is present, run tests on individual components to find the cause of the malfunction.

Spark Plug Gap Adjustment

Test Equipment:

- Wire Feeler Gauge

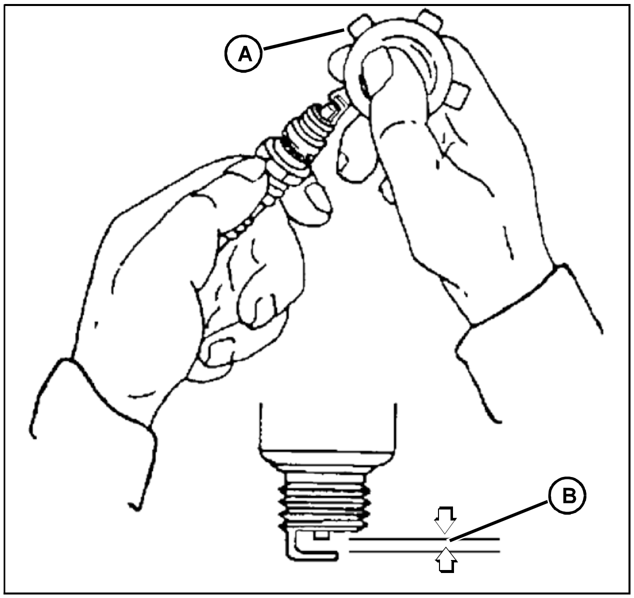
Procedure:

1. Park machine on level surface.
2. Turn key switch OFF.
3. Move forward/reverse pedals to NEUTRAL position.
4. Lock park brake.

CAUTION: Avoid injury! Engine components are HOT. Be careful not to touch, especially the exhaust pipe or muffler while making adjustments. Wear protective eye glasses and clothing.

5. Remove spark plug.

IMPORTANT: Avoid damage! Do not clean spark plug with sand paper or abrasives. Engine scoring can result.



M85608

6. Scrape or wire brush deposits from spark plug.
7. Inspect spark plug for:
    - Cracked porcelain
    - Pitted or damaged electrodes
8. Check spark plug gap using a wire feeler gauge (A).
9. Set gap to 0.7 mm (0.028 in.) (B).
10. Install and tighten spark plug to 20 N•m (15 lb-ft).

Cooling System Pressure Test

Reason:

To Inspect cooling system for leaks.

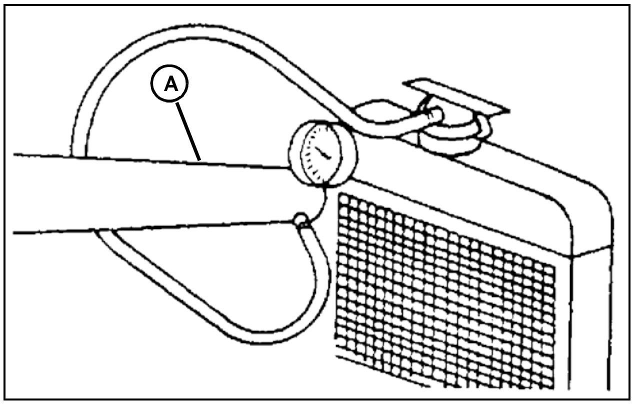
Test Equipment:

- D05104ST Cooling System Pressure Pump
- JDG692 Radiator Pressure Test Kit (Adapters)

Procedure:

1. Park machine on a level surface and turn engine OFF. Allow engine to cool before removing radiator cap.

CAUTION: Avoid injury! DO NOT remove radiator cap while engine is hot. Severe burns may result from escaping pressurized coolant. Only remove filler cap when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing cap.



T6333AW

2. Remove radiator cap and attach D05104ST Cooling System Pressure Pump (A) to radiator.

IMPORTANT: Avoid damage! DO NOT exceed a maximum pressure of 117 kPa (17 psi) during test or damage to cooling system can occur.

3. Apply 90 kPa (13 psi) pressure to cooling system. Pressure should hold steady for minimum of 15 seconds.

Results:

- Pressure should hold to specifications. If pressure decreases, check for leaks. Repair leaks or replace parts as necessary.
- If pressure test still indicates leakage after all external leaks have been stopped, a defective head gasket, cracked block, or cylinder head may be the cause.

Radiator Cap Pressure Test

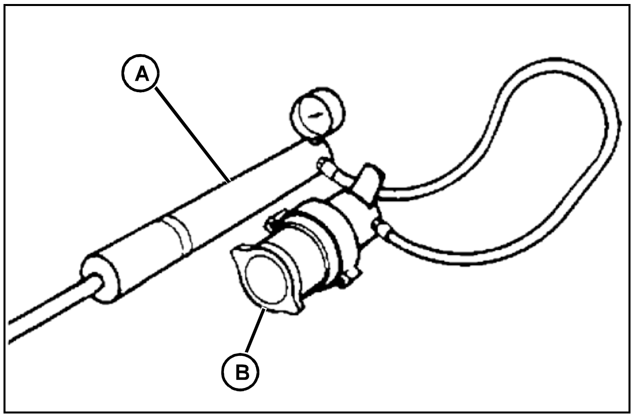
Reason:

To test radiator cap for operation in correct pressure range.

Test Equipment:

- D05104ST Cooling System Pressure Pump
- JDG692 Radiator Pressure Test Kit (Adapters)

Procedure:



T6333AX

1. Wet sealing surfaces of radiator cap (B) and install on D0510ST Cooling System Pressure Pump (A).
2. Apply pressure. Pressure valve in cap should open at 73 - 103 kPa (10.6 - 14.9 psi).

Results:

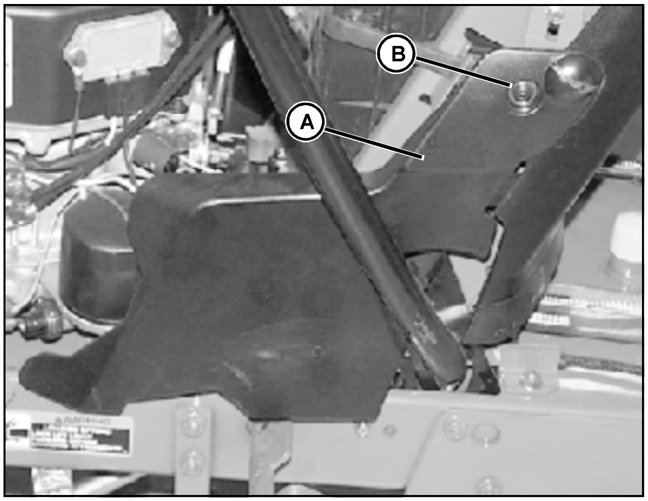
- If cap leaks, tighten and test again. Replace cap if pressure is not within specification.

Repair

Throttle Control Lever and Cable Assembly

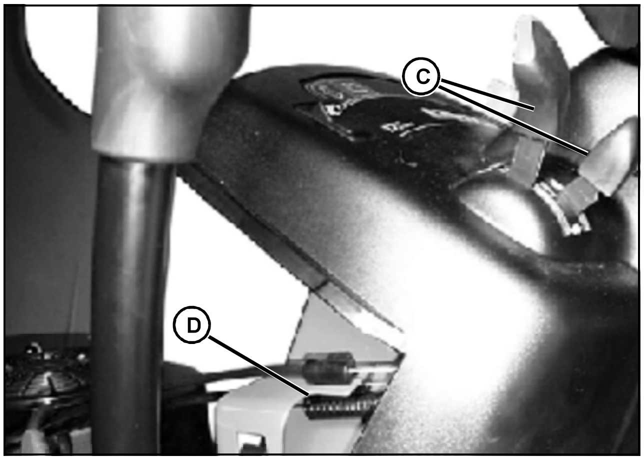
Removal and Installation:

1. Park machine on a level surface and turn engine OFF.
2. Remove hood. See “Hood Removal and Installation” on page 589 in the Miscellaneous section.



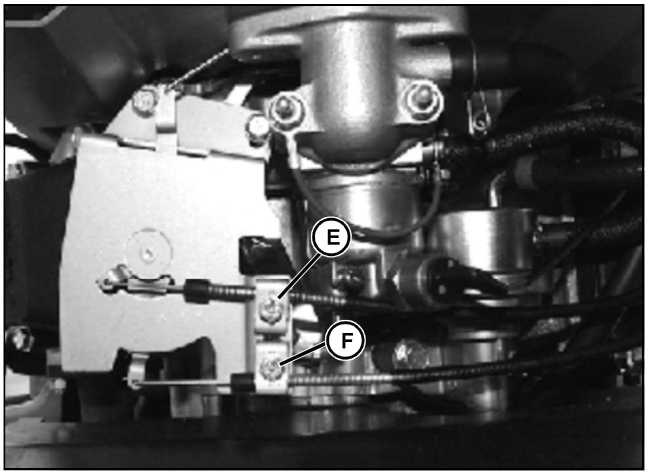
M95573

3. Remove screw (B) and left closeout panel (A).



M95596

4. Remove choke cable return spring (D).
5. Remove choke and throttle control knobs (C).



M99725

6. Loosen throttle cable clamp (E) and choke cable clamp (F) and remove cables from clamps.
7. Disconnect throttle and choke control cables at engine.
8. Remove oil pressure indicator light from socket.
9. Remove four cap screws and washers securing instrument panel.
10. Remove two cap screws and throttle control lever and cable assembly.

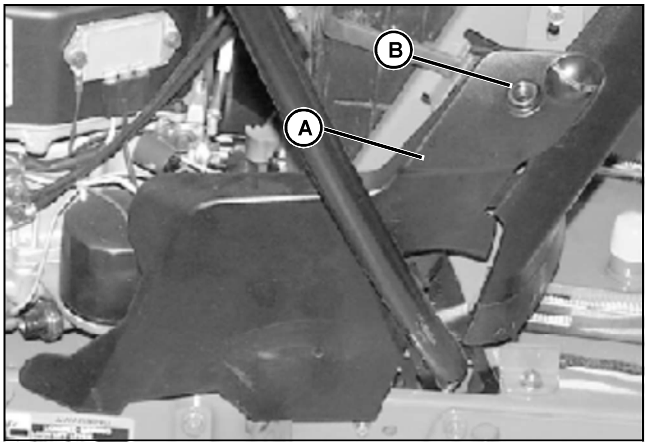
Installation is done in the reverse order of removal.

- Adjust throttle cable and choke plate. See “Throttle Cable Test and Adjustment” on page 143, and “Choke Cable Test and Adjustment” on page 143.

Engine Removal and Installation

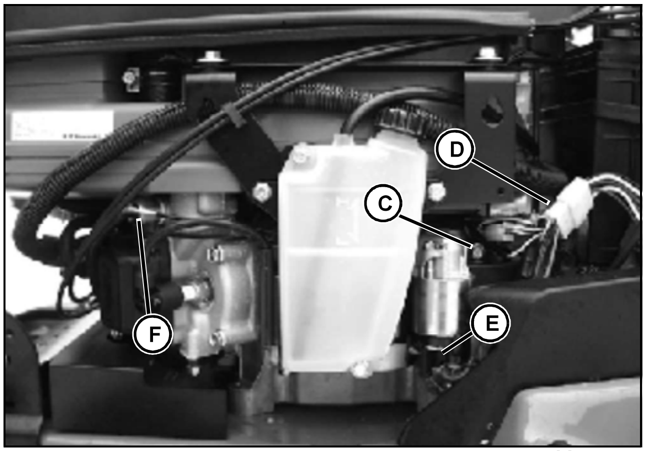
Procedure:

1. Disconnect negative (-) battery cable at battery.
2. Remove mower deck.
3. Remove engine hood. See “Hood Removal and Installation” on page 589 in the Miscellaneous section.
4. Remove muffler. See “Muffler Removal and Installation” on page 154.
5. Drain engine oil. Capacity with filter is approximately 1.8 L (1.9 qt).



M95573

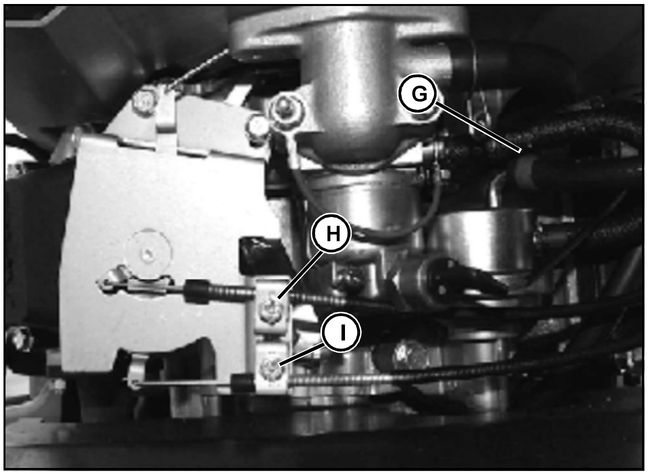
6. Remove screw (B) left and right closeout panels (A).



M83637

Left Side

7. Disconnect oil pressure switch wiring connector (F).
8. Disconnect engine harness connector (D).
9. Disconnect starting motor cables (E).
10. Remove cap screw to remove angle bracket and ground wires (C).

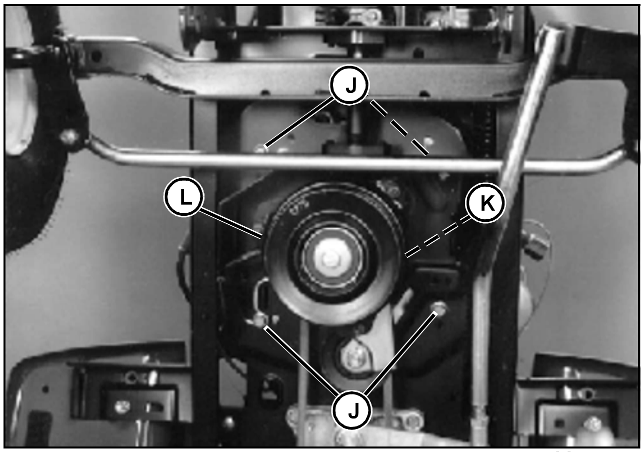


M99725

11. Loosen throttle cable clamp (H) and choke cable clamp (I) and remove cables from clamps.
12. Disconnect throttle and choke control cables at engine.
13. Remove fuel line (G) clamp.
14. Pull headlight harness away from engine.

CAUTION: Avoid Injury! Gasoline is extremely flammable. Do not smoke. Always work in a ventilated area away from open flame or spark producing equipment; including equipment that utilizes pilot lights. Wipe-up any spills IMMEDIATELY.

15. Disconnect fuel line at fuel pump and drain fuel. Wipe-up spilled fuel IMMEDIATELY.



M83639

16. Remove PTO clutch (L). See “Electric Clutch Removal and Installation” on page 347 in the Electrical section.
17. Remove drive sheave (K).
18. Remove four cap screws (J) and remove engine.

Installation is done in the reverse order of removal:

- Tighten engine mounting cap screws (J) to 34 N•m (300 lb-in.).
- Tighten muffler mounting nuts to 24.4 N•m (216 lb-in.).

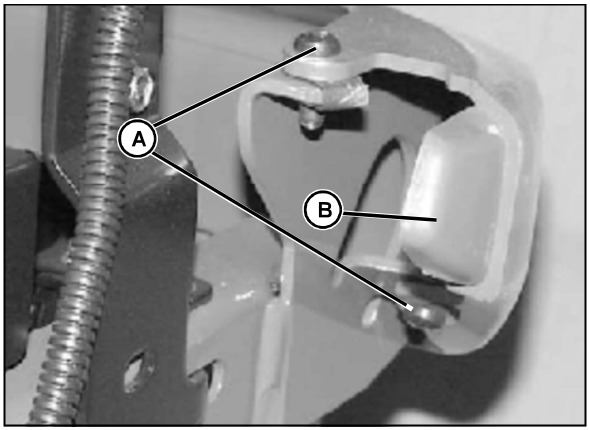
NOTE: If the engine has been rebuilt (cylinder rebored or deglazed, etc.), break-in oil should be used for the first 5 hours (maximum) of operation.

- Fill engine to proper level with oil of correct specifications.
- Apply DuBois MPG-2, Multi-Purpose Grease - M79292 to engine crankshaft before installing engine drive sheave and PTO clutch. See “Electric Clutch Removal and Installation” on page 347 in the Electrical section.
- Adjust throttle cable. See “Throttle Cable Test and Adjustment” on page 143.

Muffler Removal and Installation

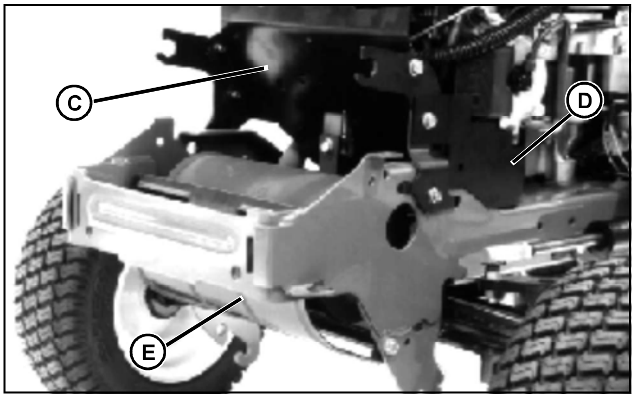
1. Remove engine hood. See “Hood Removal and Installation” on page 589 in the Miscellaneous section.

CAUTION: Avoid Injury! To prevent possible burns, allow engine to cool before removing muffler.



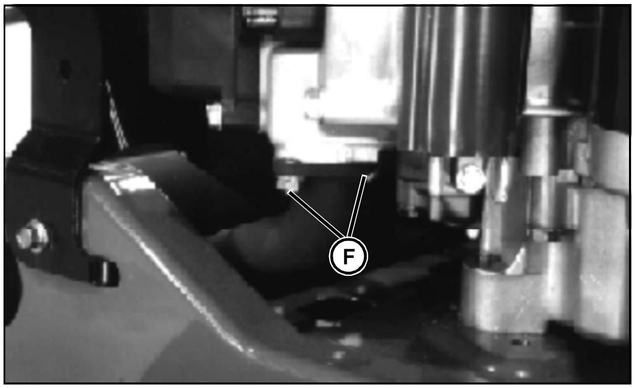
M95518

2. Remove four screws (A) securing bumper cover (B) to frame.



M82863

3. Remove heat shields (C, D, and E).



M82864

4. Remove nuts and washers (F) from both manifolds.

5. Remove muffler and gaskets.

Installation is done in the reverse order of removal.

- Use new gaskets for installation.
- Tighten exhaust manifold nuts to 24.4 N•m (216 lb-in.).

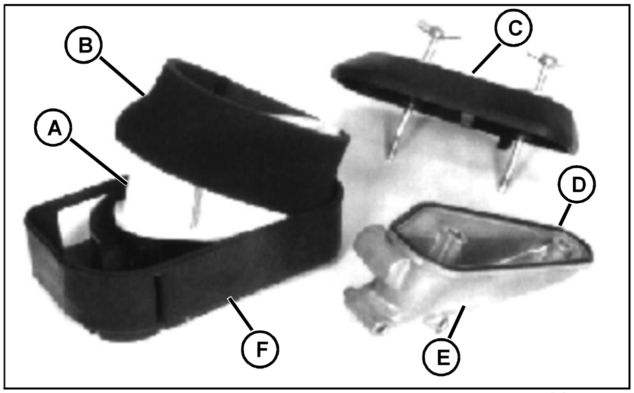
Air Cleaner

IMPORTANT: Avoid damage! Carefully remove air cleaner cover and elements. Inspect inside paper element and intake passage for signs of dust. If present, replace elements and test engine compression or inspect for damage.

Any time the air cleaner is removed, check for free choke operation during reassembly.

NOTE: Replace elements yearly or every 25 hours.

1. Remove and disassemble air cleaner.



M80157

2. Wash foam element (B) in detergent and warm water. Rinse element thoroughly to remove all traces of detergent. Squeeze out excess water - DO NOT wring out element. Let element air dry.

3. Apply 12 - 15 drops of clean engine oil to foam element. Squeeze out excess oil.

IMPORTANT: Avoid damage! Do not clean paper element (A) with solvent or compressed air.

4. Gently tap paper element to remove dust.

5. Inspect paper element.
   - Element is still usable if you can see light through it and element appears clean.
   - Replace if oily, dirty, or damaged in any way.

6. Inspect body (F), gasket (D), base (E) and cover (C) for damage. Replace parts as necessary.

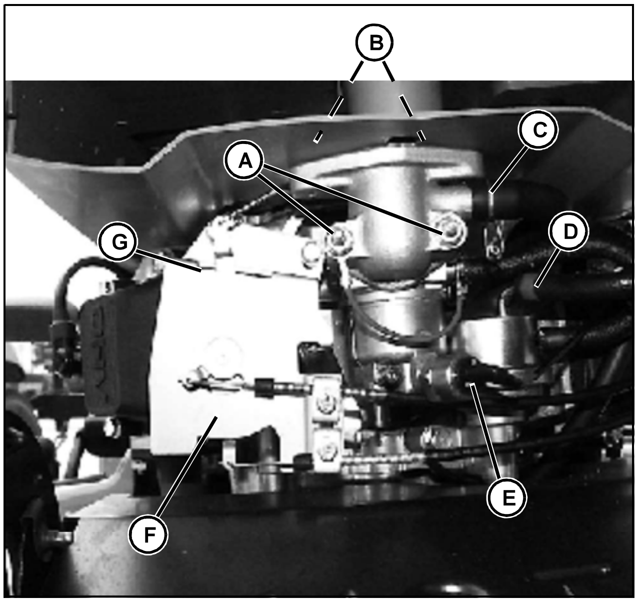
7. Assemble and install air cleaner.

Carburetor Removal and Installation

Removal:

CAUTION: Avoid Injury! Gasoline is extremely flammable. Do not smoke. Always work in a ventilated area away from open flame or spark producing equipment; including equipment that utilizes pilot lights. Wipe-up any spills IMMEDIATELY.

1. Drain fuel from carburetor. Wipe-up any spilled fuel IMMEDIATELY.

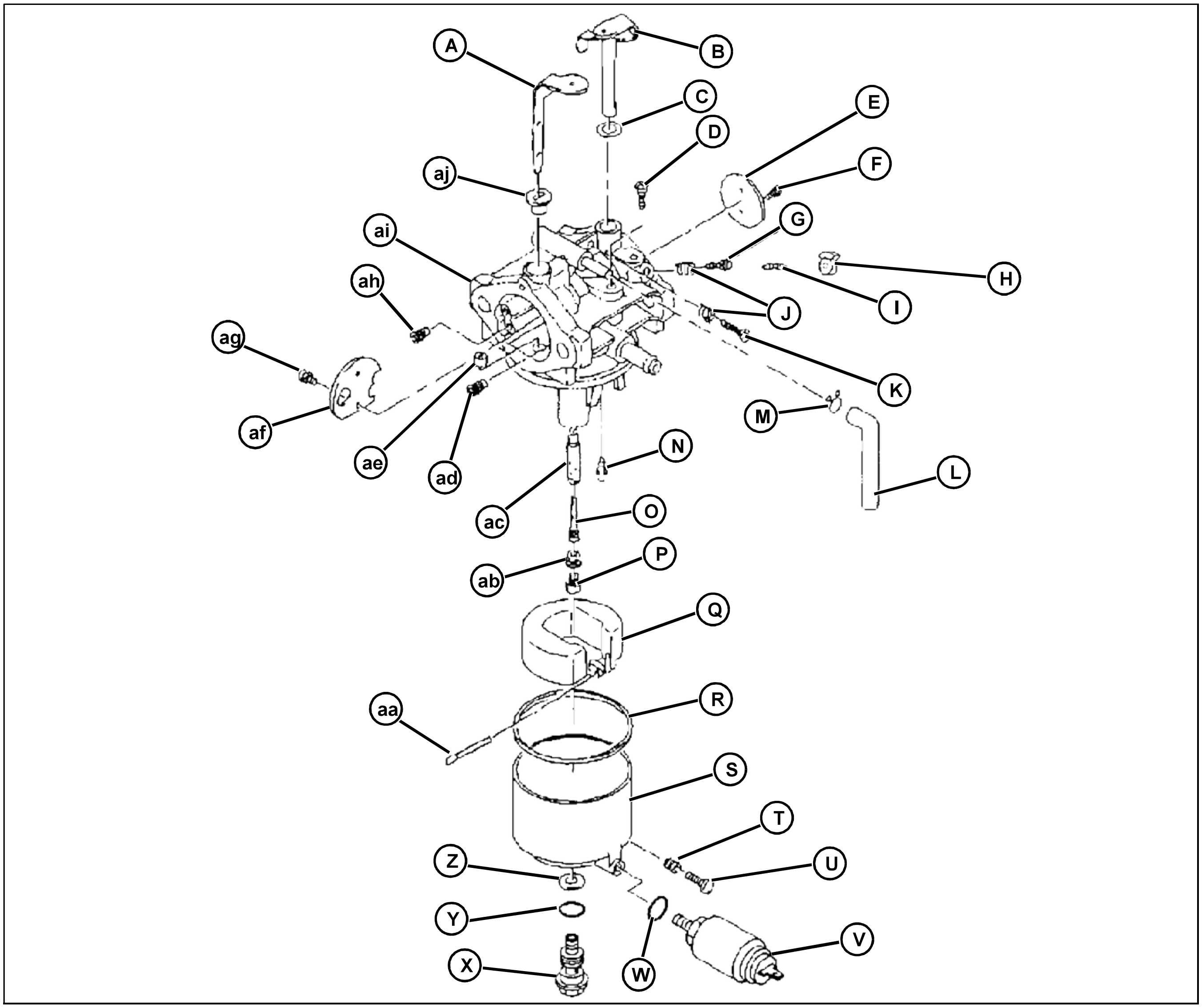


M99730

2. Disconnect breather hose (C).
3. Remove nuts (A) securing intake elbow (G) and O-ring. Remove intake elbow.
4. Loosen throttle cable and choke cable clamps and remove cables from clamps.
5. Disconnect throttle and choke control cables at engine.
6. Remove throttle control plate (F).
7. Disconnect fuel shutoff solenoid (E) wiring connector.
8. Remove governor lever from governor shaft.
9. Disconnect fuel hose (D).
10. Remove cap screws (B), carburetor, and gasket.
11. Remove governor and throttle control plate linkage from carburetor.

Installation is done in the reverse order of removal.

- Tighten screws (B) securing intake elbow (G) to engine plate to 8 N•m (71 lb-in.).
- Tighten nuts (A) securing carburetor to intake elbow (G) to 17 N•m (150 lb-in.).
- Adjust governor lever. See “Governor Adjustment” on page 144.
- Check throttle cable. See “Throttle Cable Test and Adjustment” on page 143.
- Check choke plate. See “Choke Cable Test and Adjustment” on page 143.
- Set FAST idle speed. See “Fast Idle Speed Adjustment” on page 144.
- Set SLOW idle speed. See “Slow Idle Speed Adjustment” on page 145.



M83409

A - Choke Shaft
B - Throttle Shaft
C - Seal
D - Pilot Jet
E - Throttle Plate
F - Screw (Apply Thread Lock and Sealer)
G - Slow Idle Mixture Screw
H - Black Limiter (CARB/EPA)
I - Slow Idle Mixture Screw (CARB/EPA)
J - Springs
K - Slow Idle Stop Screw
L - Vent Hose
M - Clamp
N - Inlet Needle
O - Nozzle
P - Main Jet
Q - Float
R - Gasket
S - Fuel Bowl
T - Spring
U - Drain Screw
V - Fuel Shutoff Solenoid (9.8 N•m (7 lb-in.)
W - Gasket
X - Bowl Screw
Y - O-Ring
Z - Washer
AA- Float Pin
AB- Main Jet Holder
AC- Main Nozzle
AD- Pilot Air Jet
AE- Bushing
AF- Choke Plate
AG- Screw (Apply Thread Lock and Sealer)

AH- Main Air Jet

AI - Carburetor Body

AJ- Bushing

Disassembly, Cleaning and Assembly:

CAUTION: Avoid Injury! DO NOT attempt to repair, replace jets, or adjust the engine emissions carburetor unless you are a factory trained technician with authorization to service CARB/EPA Certified Emissions Carburetors.

IMPORTANT: Avoid damage! There are a number of ball plugs on/in the carburetor that should not be removed.
To remove float, use a long-nosed pliers on the deformed end of the float pin. DO NOT strike opposite end of pin. Damage to pin holder may result.

IMPORTANT: Avoid damage! DO NOT clean holes or passages with small drill bits or wire.

NOTE: If all rubber or plastic parts cannot be removed for cleaning, use a cleaning solvent with a high flash point that will not damage these parts when cleaning.

1. Remove rubber and plastic parts from carburetor. Soak all carburetor metal parts in a carburetor cleaning solution for 1/2 hour maximum.

CAUTION: Avoid Injury! Reduce compressed air to less than 210 kPa (30 psi) when using for cleaning purposes. Clear area of bystanders, guard against flying chips, and wear personal protection equipment including eye protection.

IMPORTANT: Avoid damage! Rinse carburetor parts in warm water to neutralize corrosive action of cleaner on aluminum. Do not use rags or paper to dry parts; lint can plug holes and passages in carburetor.

2. Rinse carburetor parts in warm water and dry with compressed air. Do not use rags or paper to dry parts; lint can plug holes and passages in carburetor.

3. Inspect all parts for wear or damage.
   - Inspect the carburetor body for wear or damage. Verify all sealing surfaces and flanges are smooth and free of nicks or burrs. If worn or damaged, replace the float assembly and carburetor body as a set.
   - Inspect the inlet needle for wear or damage. The tip should be smooth, without any grooves, scratches or cracks. If worn or damaged, replace the needle and carburetor body as a set.
   - Inspect the SLOW idle mixture screw tapered end for wear or damage. Replace if necessary.

4. Turn the SLOW idle mixture screw in until it lightly seats and back it out 1-3/8 turns.

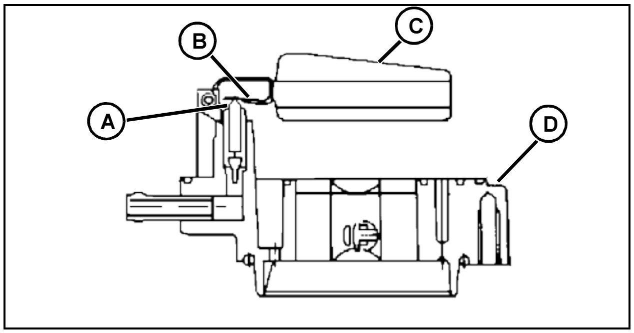
5. Install the choke plate with the metering hole toward the fuel inlet joint of the carburetor.

6. Verify that the float pin extends the same distance on both sides of the float hinge bracket when assembling the carburetor.

7. Verify that the throttle and choke valves move freely and that the shaft bosses are not elongated or worn. If shaft bosses have any of these conditions, replace the carburetor body.

Float Level Adjustment:

NOTE: Plastic float is non-adjustable.



M57333

1. Adjust float level. Hold carburetor upside down at eye level with float assembly installed.

2. Gently support the float (C) with a finger and lower it slowly until the float arm tab (B) just touches the inlet needle (A). The float lower surface should be parallel with the body mating surface (D).

3. If necessary, bend float arm tab to adjust float level.

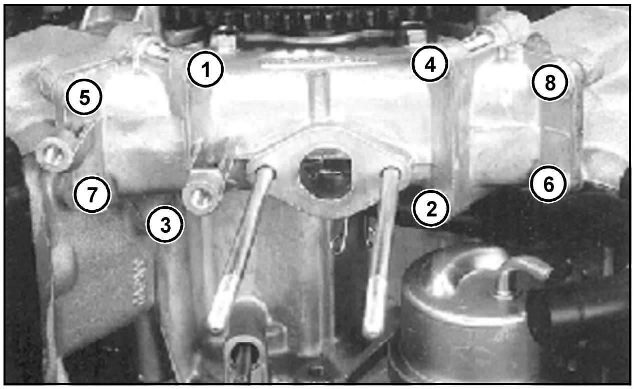
Intake Manifold

Removal and Installation:

1. Remove cooling air duct. See “Cooling Air Duct” on page 160.

2. Remove carburetor. See “Carburetor Removal and Installation” on page 155.

IMPORTANT: Avoid damage! To prevent warpage, loosen cap screws 1/4 turn at a time, in sequence shown until all cap screws are loose.



M83410

3. Loosen mounting cap screws in sequence shown.

4. Remove cap screws, intake manifold, and gaskets. Discard gaskets.

Installation is done in the reverse order of removal.

- Install new gaskets.
- Tighten cap screws in sequence to specifications.

Torque Specifications:

Initial Torque	**3 N•m (27 lb-in.)**
Final Torque	**6 N•m (53 lb-in.)**

Inspection:

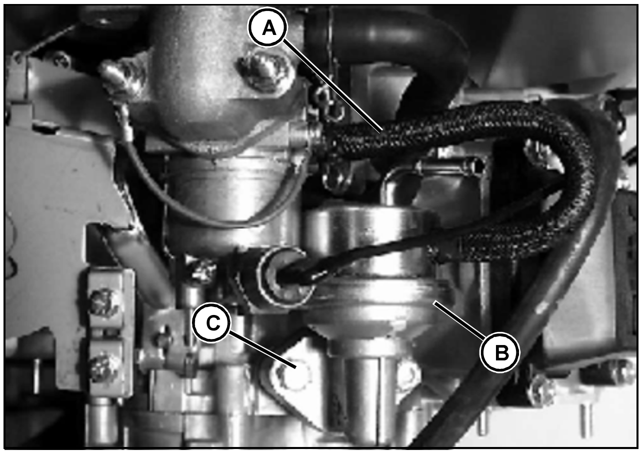
- Visually inspect manifold passages for corrosion, cracks, porous castings, or deposits. Clean or replace as necessary.

NOTE: Cracks not visible to the eye may be detected by coating the suspected area with a mixture of 25% kerosene and 75% light engine oil. Wipe area dry and immediately apply coating of zinc oxide dissolved in wood alcohol. If crack is present, coating becomes discolored at the defective area. Replace block if any cracks are found.

Fuel Pump

Removal/Installation:

> **⚠ CAUTION: Avoid Injury! Gasoline is extremely flammable. Do not smoke. Always work in a ventilated area away from open flame or spark producing equipment; including equipment that utilizes pilot lights. Wipe-up any spills IMMEDIATELY.**



M99579

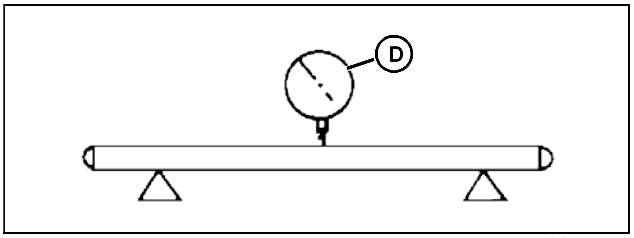
1. Disconnect outlet (A) and inlet hoses. Wipe-up any spilled fuel IMMEDIATELY.
2. Remove cap screws (C).
3. Remove fuel pump (B), gaskets, insulator, and push rod.
4. Inspect all parts for wear or damage; replace if necessary. See "Inspection:" procedure below.

Installation is done in the reverse order of removal.

- Tighten cap screws (C) to 16 N•m (142 lb-in.).

Inspection:

- Inspect pump and insulator for wear or damage; replace if necessary.



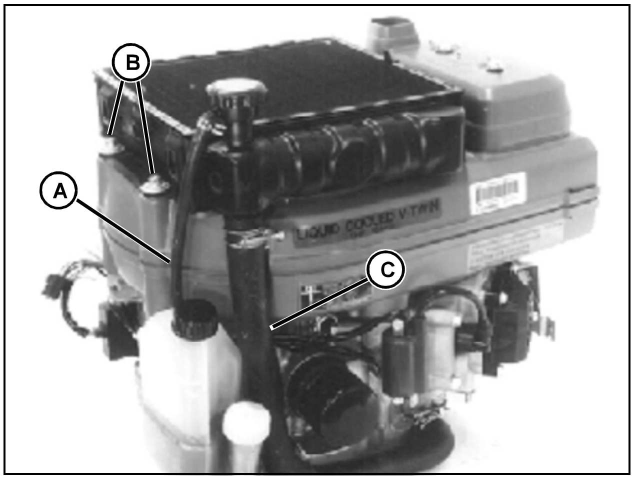
M50044

- Turn rod slowly and inspect push rod for bend using V-blocks and a dial indicator (D). Replace if variation is greater than 0.05 mm (0.002 in.).

Radiator Removal and Installation

CAUTION: Avoid Injury! Explosive release of fluids from pressurized cooling system can cause serious burns. Shut off engine and allow to cool. Only remove filler cap when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing cap.

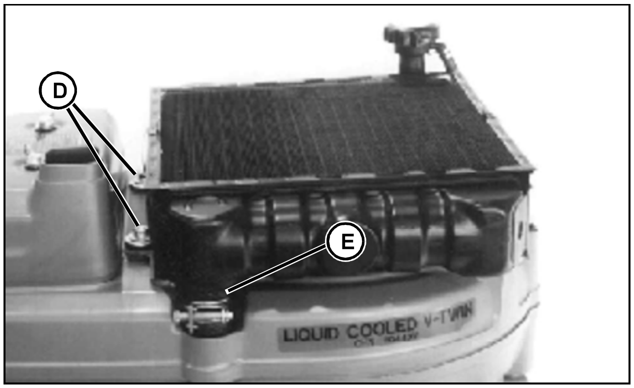
1. Loosen radiator cap to relieve pressure. Then close tightly.
2. Disconnect bypass hose from cylinder head to drain cooling system. Capacity is approximately 2.1 L (2.2 US qt).
3. Reconnect bypass hose.



M83411

Right Side Shown

4. Remove overflow hose (A) from reservoir.
5. Disconnect outlet hose (C).
6. Remove nuts and washers (B).



M83412

Left Side Shown

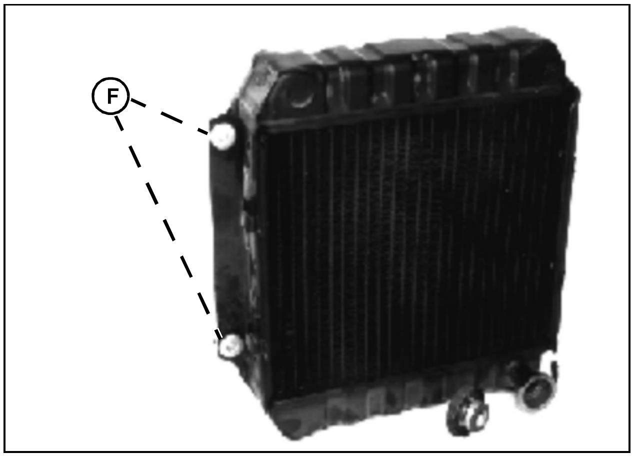
7. Disconnect inlet hose (E).
8. Remove nuts and washers (D).
9. Remove and inspect radiator. See "Inspection:" procedure below.

Installation is done in the reverse order of removal.

- Fill engine cooling system to proper level with coolant of correct specifications.

Inspection:

1. Remove deflection screen.



M51696

- Inspect rubber dampeners (four used) (F) for excessive wear or damage. Replace if necessary.

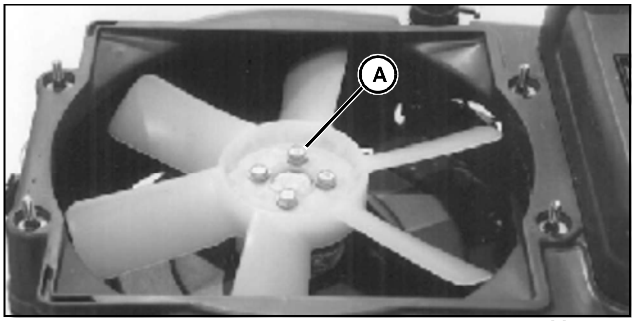
CAUTION: Avoid Injury! Reduce compressed air to less than 210 kPa (2 bar) (30 psi) when using for cleaning purposes. Clear area of bystanders, guard against flying chips, and wear personal protection equipment including eye protection.

- Check radiator for debris lodged in fins. Clean radiator using compressed air or low pressure washer.
- Inspect radiator for bent fins, cracks and damaged seams. Repair or replace radiator if necessary.

Cooling Fan

Removal and Installation:

1. Remove radiator. See “Radiator Removal and Installation” on page 159.



M83413

2. Remove four cap screws (A) and cooling fan.

3. Inspect fan for cracks, broken blades or other damage. Replace as necessary.

Installation is done in the reverse order of removal.

- Tighten cap screws to 6 N•m (53 lb-in.).

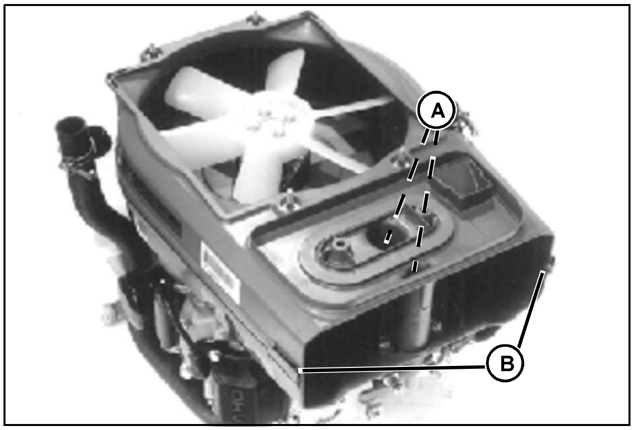
Cooling Air Duct

Removal/Installation:

1. Remove radiator. See “Radiator Removal and Installation” on page 159.

2. Remove air cleaner assembly. See “Air Cleaner” on page 154.

IMPORTANT: Avoid damage! Remove cap screws and collars carefully. Parts may fall into the air intake.

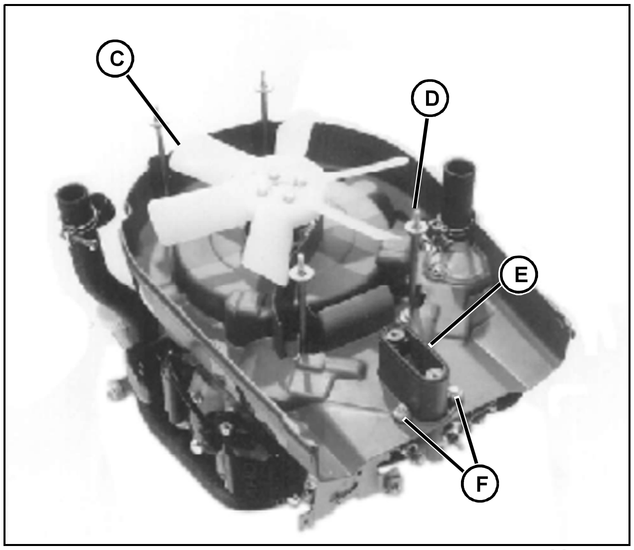


M83414

3. Remove cap screws and collars (A).

4. Remove retaining clips (B).

5. Remove top half of air duct.



M83415

6. Remove cooling fan (C). See “Cooling Fan” on page 160.

7. Remove four studs and washers (D).

8. Remove cap screws and collars (F).

9. Remove lower half of air duct.

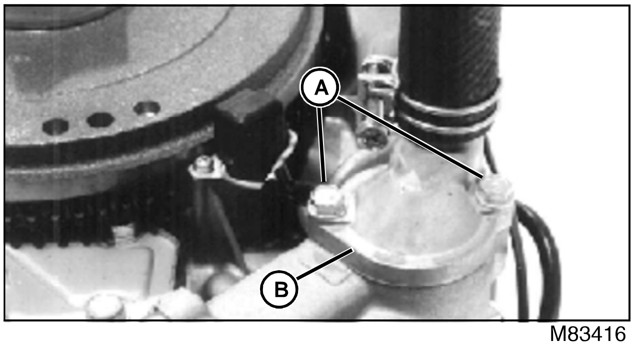
Installation is done in the reverse order of removal.

- Check condition of O-rings (E).
- Apply Thread Lock and Sealer (Medium Strength) to threads of stud (cylinder Block ends) and tighten to 6 N•m (53 lb-in.).
- Tighten cap screws to 6 N•m (53 lb-in.).

Thermostat

Removal and Installation:

1. Remove cooling air duct. See “Cooling Air Duct” on this page.



M83416

2. Remove cap screws (A), housing (B), gasket, and thermostat. Discard gasket.

3. Clean gasket mating surface.

4. Test thermostat. See “Opening Test:” below.

Installation is done in the reverse order of removal.

- Use new gasket for installation.
- Tighten cap screws (A) to 6 N•m (53 lb-in.).

Opening Test:

Reason:

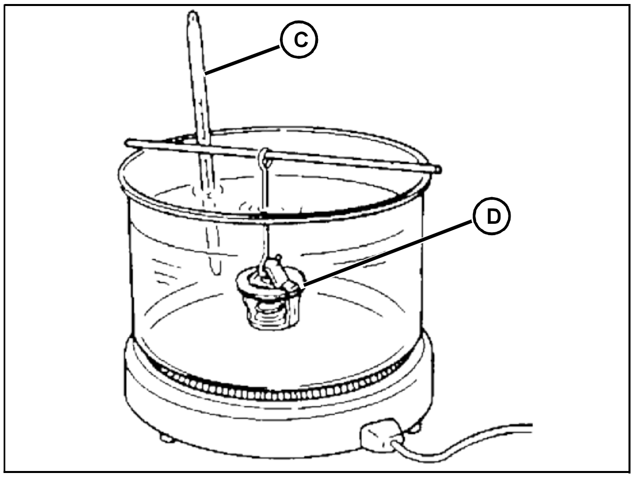
To determine opening temperature of the thermostat.

Test Equipment:

- Thermometer
- Glass Container
- Heating Unit

Procedure:

CAUTION: Avoid Injury! DO NOT allow thermostat or thermometer to rest against the side or bottom of the glass container when heating water. Thermometer or glass container may rupture if overheated.



M82122A

1. Suspend thermostat (D) and a thermometer (C) in a container of water.

2. Heat and stir the water. Observe opening action of thermostat and compare temperatures with specifications.

3. Remove thermostat and observe its closing action as it cools.

Specifications:

Begin Opening . . . . 63 - 66° C (145 - 150° F)
Fully Open. . . . . 80° C (176° F)

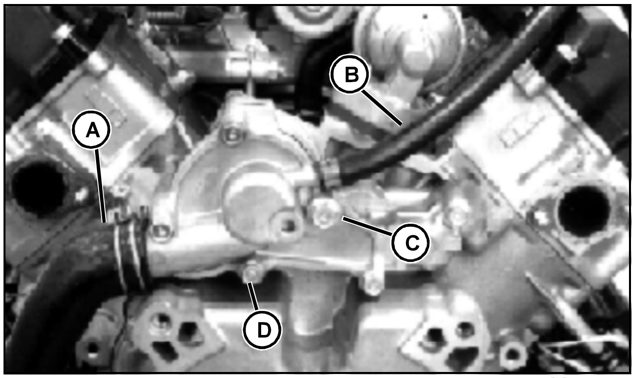
Results:

- If thermostat does not open according to specifications, replace.
- If closing action is not smooth and slow, replace thermostat.

Coolant Pump

Removal/Installation:

NOTE: Note length and position of mounting cap screws to aid in installation.



M82906

1. Disconnect radiator hose (A) and bypass hose (B). Remove mounting cap screws (D), cap screw (C), pump and gaskets.

2. Inspect all parts for wear or damage. See "Disassembly/Inspection/Assembly:" procedure below.

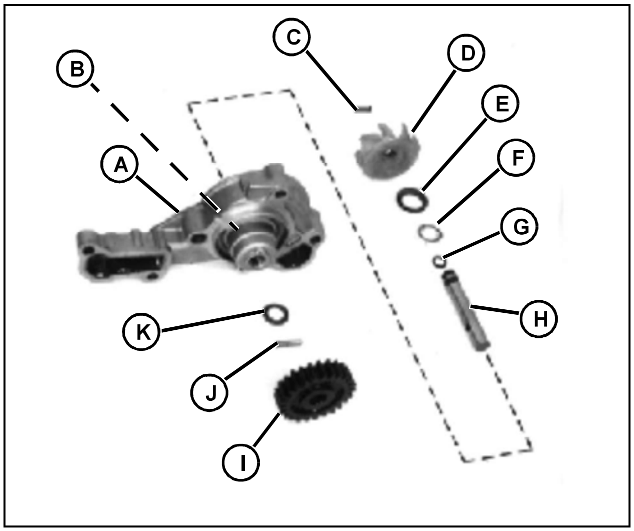
Installation is done in the reverse order of removal.

- Use new gaskets for installation.
- Tighten M6 cap screws (D) to 9 N•m (80 lb-in.).
- Tighten M8 cap screw (C) to 21 N•m (186 lb-in.).

NOTE: M8 cap screw goes through crankcase cover into crankcase.

Disassembly/Inspection/Assembly:

IMPORTANT: Avoid damage! Leakage from the coolant pump will drain into the engine block and could cause engine damage. If there is any doubt of the condition of the coolant pump, replace it as a complete assembly.



M51706

A - Housing
B - Mechanical Seal
C - Dowel Pin
D - Impeller (Coat with Coolant)
E - Oil Seal
F - Mating Ring
G - O-Ring (Apply Grease)
H - Impeller Shaft
I - Spur Gear (Coat with Oil)
J - Dowel Pin
K - Washer

1. Remove spur gear using a puller.

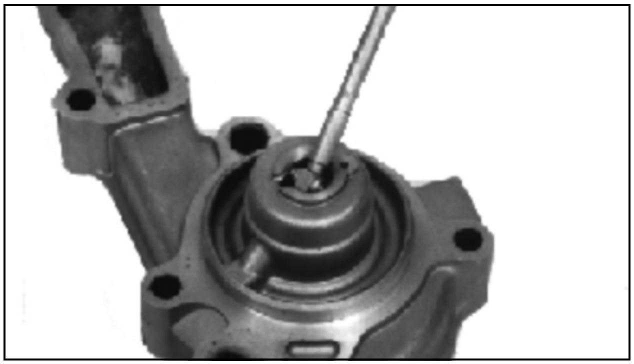
2. Remove impeller assembly from housing. Disassemble impeller assembly.

NOTE: Mechanical seal is sealed in place and will be difficult to remove.

3. Drive old mechanical seal from housing.

M51716

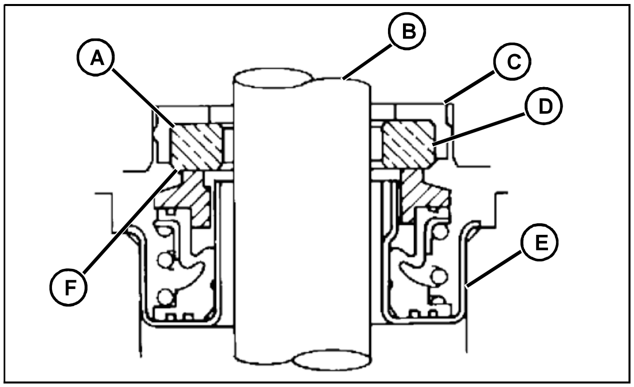
4. Measure outside diameter of impeller shaft. If shaft diameter is less than 9.94 mm (0.391 in.), or shows any signs of corrosion, replace shaft.



M51717

5. Measure inside diameter of impeller shaft bore in housing. Replace housing if shaft bore is greater than 10.09 mm (0.397 in.).

Assembly is done in the reverse order of disassembly.



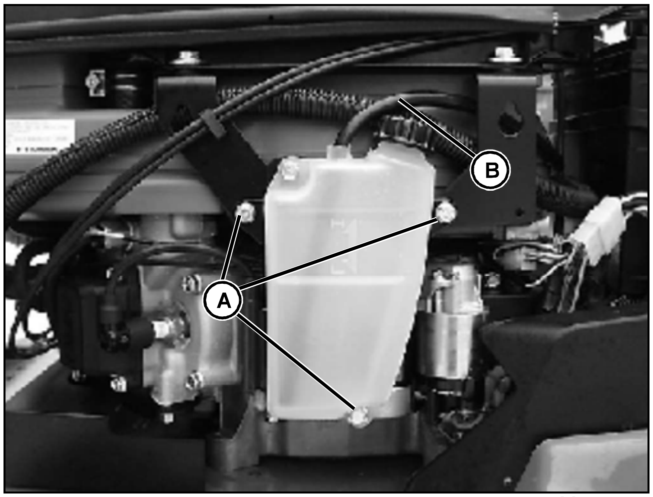
M51707

A - Spur Gear
B - Shaft
C - Oil Seal
D - Mating Ring
E - Mechanical Seal
F - Mating Surface

- Install mechanical seal using special driver included in seal kit.

Overflow Reservoir

Removal and Installation:



M99728

1. Remove hose (B).
2. Remove cap screws (A) and reservoir.

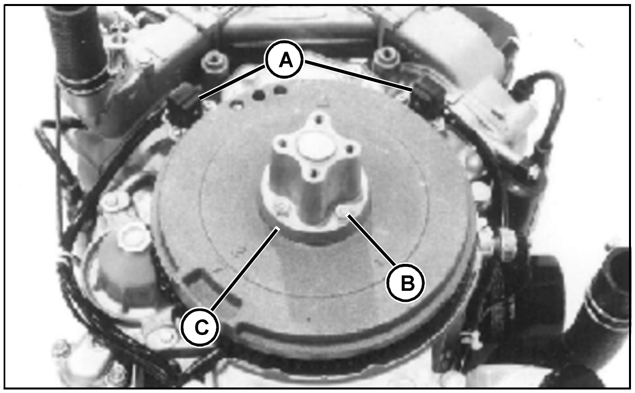
Installation is done in the reverse order of removal.

- Tighten cap screw (A) to 4 N•m (35 lb-in.).

Flywheel Removal and Installation

Procedure:

1. Remove cooling air duct. See “Cooling Air Duct” on page 160.



M83418

2. Move pulser coils (A) away from flywheel.
3. Remove fan extension (C).
4. Hold flywheel and remove mounting nuts and washers (B).
5. Remove flywheel using a flywheel puller.

Installation is done in the reverse order of removal.

- Tighten mounting nuts to 6 N•m (53 lb-in.).

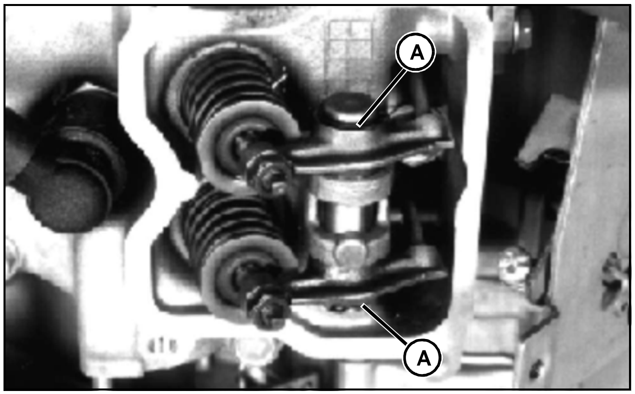
NOTE: Pulser coils have a fixed air gap that is not adjustable.

Rocker Arm Assembly

Removal and Installation:

NOTE: The following procedures are done separately on both cylinder head assemblies.

1. Remove spark plug.
2. Remove rocker arm cover.
3. Turn crankshaft until piston is at highest position on compression stroke (both valves will be closed).



M51708

4. Remove snap rings (A), shaft and arms.

IMPORTANT: Avoid damage! Mark push rods for reassembly in original locations.

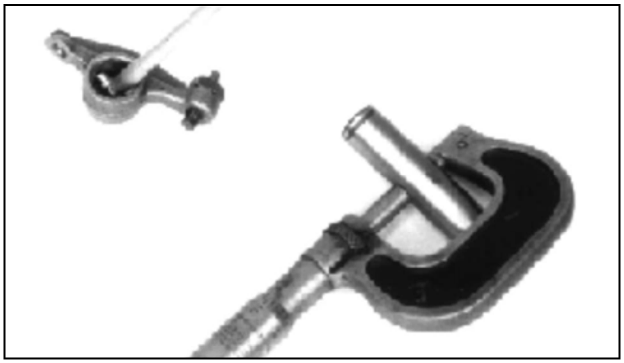
5. Remove push rods.
6. Inspect all parts for wear or damage. See "Inspection:" procedure below.

Installation is done in the reverse order of removal.

IMPORTANT: Avoid damage! Be sure piston is at top dead center. Align rocker arms over push rods during assembly.

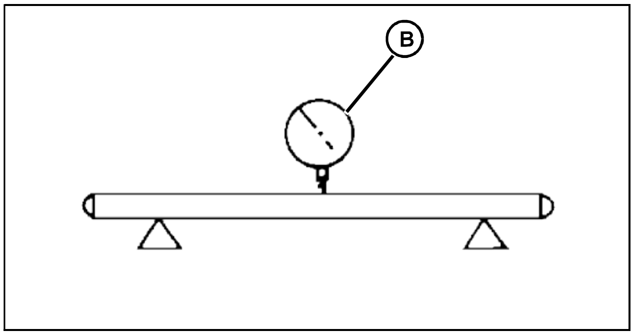
- Adjust valve clearance. See “Valve Clearance Test and Adjustment” on page 146.

Inspection:



M51709

- Measure outer diameter of rocker arm shaft. Replace if shaft diameter measures less than 11.95 mm (0.470 in.).
- Measure inner diameter of rocker arm bearing. Replace bearing if inside diameter is greater than 12.07 mm (0.475 in.).



M50044

- Inspect push rod for bend using V-blocks and a dial indicator (B). Turn rod slowly and read variation on indicator. Replace if variation is greater than 0.80 mm (0.031 in.).

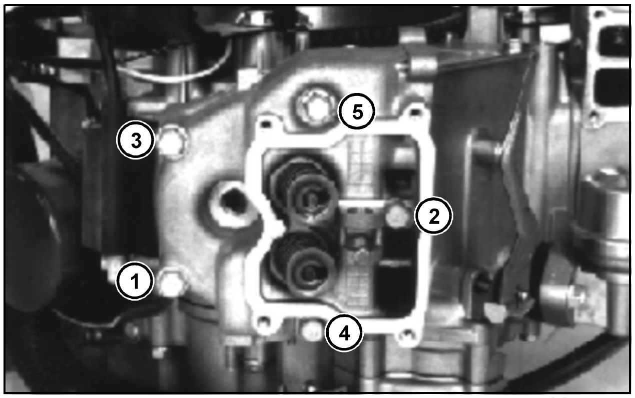
Cylinder Head and Valves

Removal/Installation:

NOTE: Number one cylinder head shown. Number two cylinder head is the same except it has a thermostat housing, by-pass port, and a thermo-switch port.

1. Remove intake manifold. See “Intake Manifold” on page 157.
2. Remove rocker arm cover, rocker arm assembly, and push rods. See “Rocker Arm Assembly” on page 163.
3. Remove spark plug.

IMPORTANT: Avoid damage! Loosen cylinder head bolts 1/4 turn at a time, in the sequence shown to avoid warping the cylinder head.



M51710

4. Remove cylinder head assembly and gasket.
5. Disassemble and inspect cylinder head and valves. See "Inspection and Replacement:" procedures below.

Installation is done in the reverse order of removal.

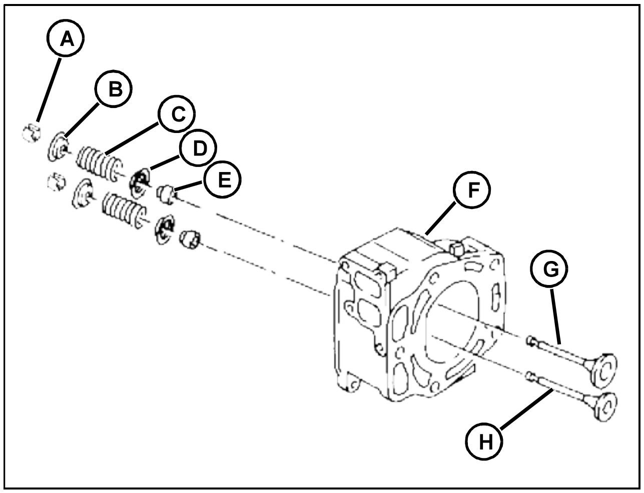
- Use new gaskets for installation.
- Adjust valve clearance. See “Valve Clearance Test and Adjustment” on page 146.

IMPORTANT: Avoid damage! Torque should be applied in the sequence shown. Install intake manifold before tightening cylinder head cap screws to final torque.

Torque Specifications:

Initial Torque . . . . 13 N•m (115 lb-in.)
Final Torque . . . . 21 N•m (186 lb-in.)
Spark Plug . . . . 20 N•m (15 lb-ft)

Disassembly and Assembly:



M82905AE

A - Valve Keepers
B - Retainer
C - Spring

D - Retainer
E - Seals
F - Cylinder Head
G - Exhaust Valve
H - Intake Valve

- Inspect all parts for wear or damage. See "Inspection and Replacement:" procedures below.
- Intake and exhaust valve guides cannot be replaced; replace head if worn.

IMPORTANT: Avoid damage! Bottom spring retainer can only be removed with valve stem seal. Removal of retainer or seal damages stem seal. Inspect seal. If seal is not damaged, do not remove it.

- If necessary to replace stem seal, remove with screwdriver.
- Apply clean engine oil on intake and exhaust valve stems during assembly.

Inspection and Replacement:

Cylinder Head -

1. Remove carbon deposits from combustion chamber and gasket surface using SCOTCH-BRITE, abrasive pads or an equivalent.

CAUTION: Avoid Injury! Reduce compressed air to less than 210 kPa (2 bar) (30 psi) when using for cleaning purposes. Clear area of bystanders, guard against flying chips, and wear personal protection equipment including eye protection.

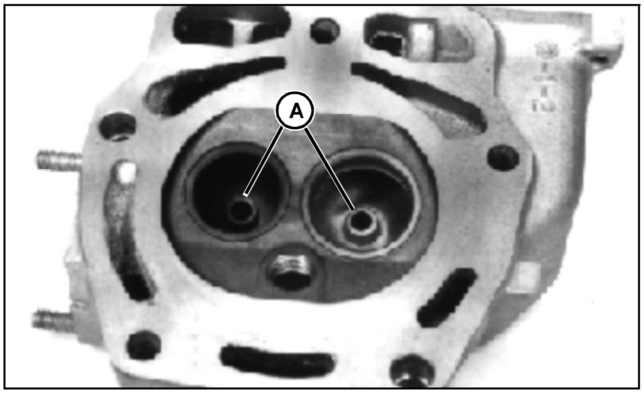
2. Clean head with a suitable solvent and dry with compressed air.
3. Inspect head for cracks or damage.
4. Inspect gasket surface for burrs and nicks.

M51712

5. Put cylinder head on a surface plate. Check for distortion at several points around the head using a feeler gauge. Replace head if distortion is more than 0.06 mm (0.002 in.).

Valve Guides -

NOTE: Intake and exhaust valve guides cannot be replaced; replace head if worn.

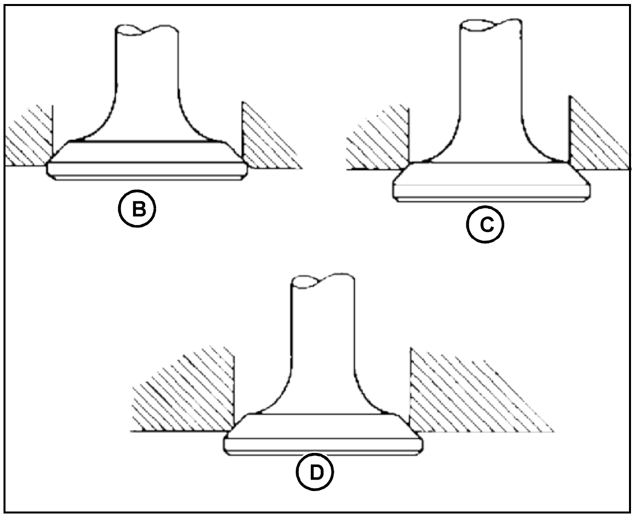


M51713

1. Clean inside of valve guides (A) with valve guide cleaner.
2. Measure inside diameter of valve guides. Replace cylinder head if inside diameter is greater than 5.06 mm (0.199 in.).

Valve Seats -

1. If valve seats are loose, warped or distorted beyond reconditioning, replace cylinder head. Pitted or worn seats can be re-faced using a seat cutter.



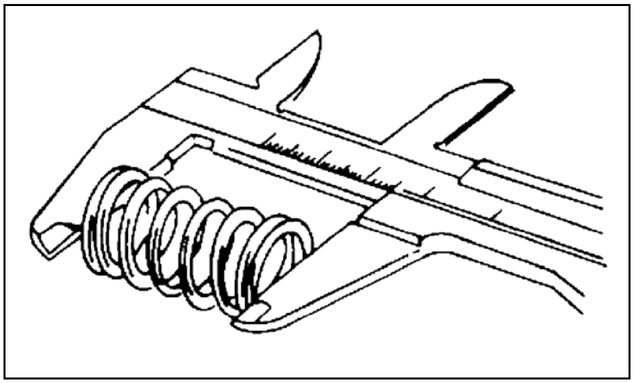
M18615

2. Check valve seating pattern for correct width and evenness all around. (Note seat too deep (B), seat too high (C) and correct seat position (D) above.) If valve seat width is not within 0.5 - 1.1 mm (0.020 - 0.043 in.), recondition valve seat. See “Recondition Valve Seats” on page 168.

3. Lap valve after reconditioning with lapping compound and recheck valve seating surface for proper width and evenness of seating pattern. See “Lap Valves” on page 168.

Valve Springs -

1. Inspect spring for pitting, rust, and burrs. Replace if necessary.



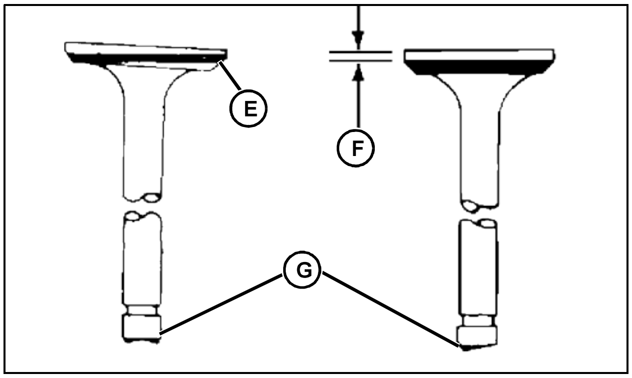
M50036

2. Measure spring free length. Replace spring if measurement is less than 27.30 mm (1.074 in.).

Intake and Exhaust Valves -

1. Remove carbon from valve head, face, and stem with a power-operated wire brush. Be sure carbon is removed, not merely burnished.

2. Inspect valve head, face, and stems for defects. Replace if necessary.

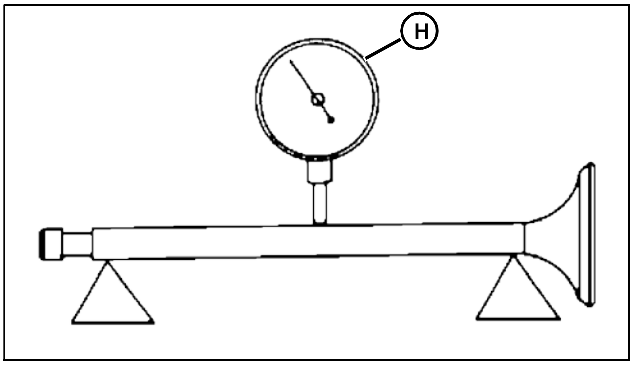


M38087

3. Replace warped valves (E) or valves with less than 0.50 mm (0.020 in.) margin (F). Valve stem ends (G) should be ground square before checking valve to tappet clearance.

M53961

4. Measure outside diameter of valve stem. Replace if diameter is less than specifications.



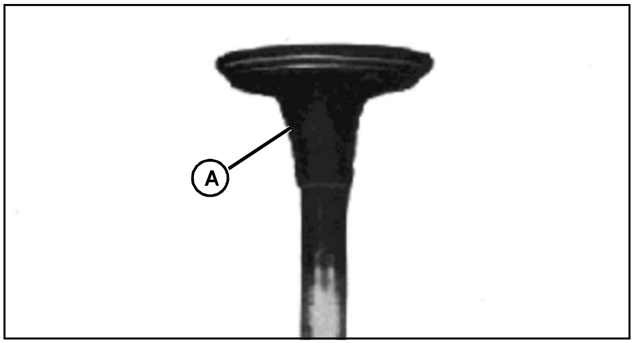
M51753

5. Check valve stem for bend using V-blocks and a dial indicator (H). Turn valve slowly and read variation on indicator. Replace if variation is greater than 0.03 mm (0.001 in.).

Minimum Valve Stem OD Specifications:

Intake	**4.93 mm (0.194 in.)**
Exhaust	**4.92 mm (0.193 in.)**

Analyze Valves



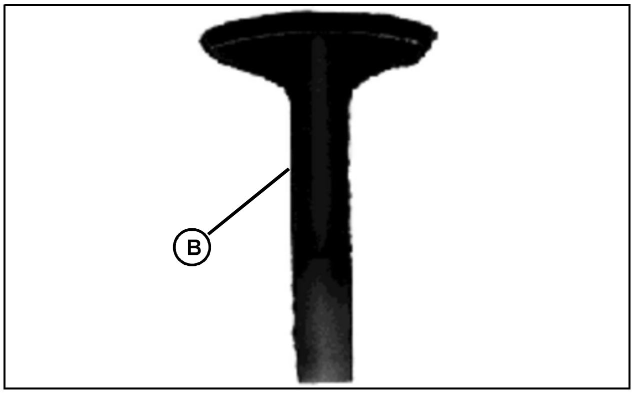
M29934

Lead deposits (A) on the intake valve are caused by exhaust gas leakage past the valve. This indicates that the valve is not seating properly.

IMPORTANT: Avoid damage! DO NOT grind the exhaust valve or life will be shortened.

Grind the intake valve and resurface the seat to correct this condition.

NOTE: Be sure to reset valve-to-tappet clearance after grinding valves.

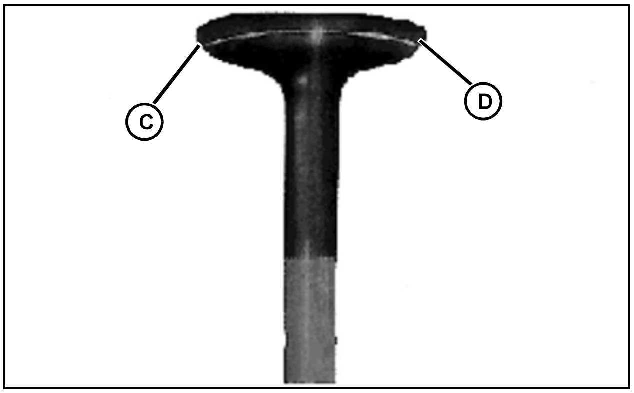


M5563

Valve stem corrosion (B) is caused by moisture in the engine. Moisture in the fuel-air mixture can condense inside the engine when the engine is stopped and cools down.

Valve corrosion can also occur during storage. Fogging or pouring oil in the combustion chamber before storing helps prevent valve corrosion.

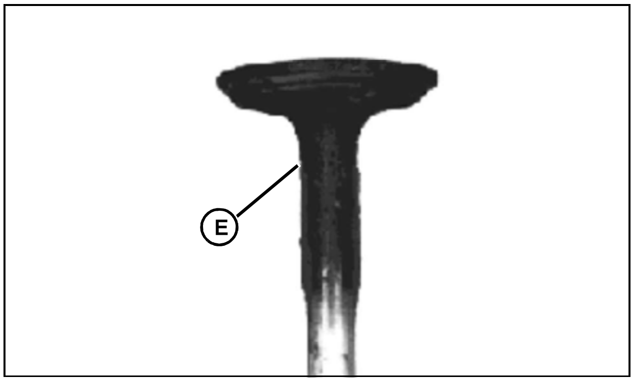
Corroded or pitted valves collect deposits and may cause sticking valves. Replace badly corroded or pitted valves.



M30024

Exhaust valves are designed to function in temperatures exceeding 2760° C (5000° F). However, when operating at high temperatures for long periods of time, valve burning may occur. Valves running too hot will show a dark discoloration of the valve stem into the area protected by the valve guide. Another indication is distortion of the valve margin (C) and valve face (D). Valve inserts may also begin to burn away.

Other causes for valves running hot are worn valve guides or valve springs, incorrect valve clearance, lean fuel-air mixture, and incorrect or overheated spark plug.



M29936

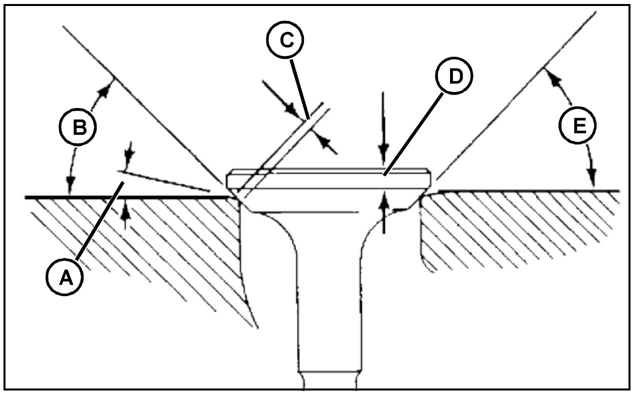
Using old or stale gasoline is a common cause for sticky valves.

This gummy deposit (E) can be seen on the valve. When this condition exists, the carburetor may also contain gummy deposits and will require cleaning.

Always use fresh gasoline and drain fuel tank, lines, and carburetor before storing machine.

Recondition Valve Seats

1. Inspect valve seats for damage. If seats are loose, warped or distorted beyond reconditioning, replace cylinder head. Pitted or worn seats can be refaced using a seat cutter.



M9552

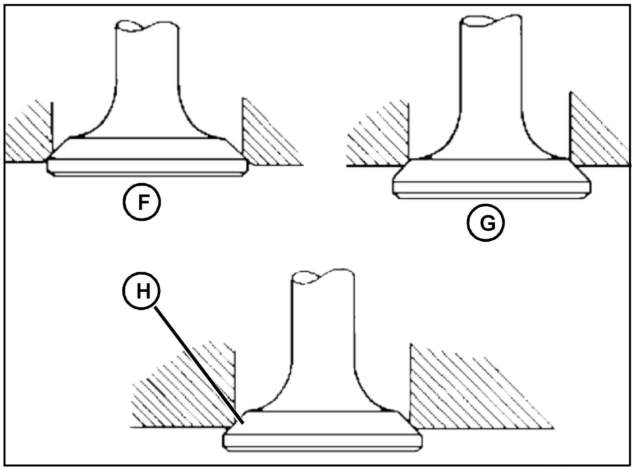
2. To recondition seat, cut at 45× angle (B) to clean up seat. Cut narrowing angle at 30× (A). Finish cut at 45× to establish seating surface width.

3. Cut valve seating surface as close as possible to specifications.

4. Lap valves to seats after re-facing.

5. Center valve seat on the valve face.

6. Check seat for good contact using Prussian Blue Compound.



M18615

7. Check valve seating pattern for correct width and evenness all around. (Note seat too deep (F), seat too high (G) and correct seat position (H) above.) If valve seat width is not within 0.5 - 1.1 mm (0.020 - 0.043 in.), recondition valve seat.

8. Lap valve after reconditioning with lapping compound and recheck valve seating surface for proper width and evenness of seating pattern. See “Lap Valves” on page 168.

Specifications:

Valve Seating Surface (C) (Standard) . . . . 0.80 mm (0.031 in.)

Seat Width Tolerance . 0.50 - 1.10 mm (0.020 - 0.043 in.)

Valve Seat Angle (B) . . . . 45°

Valve Face Angle (E) . . . . 45°

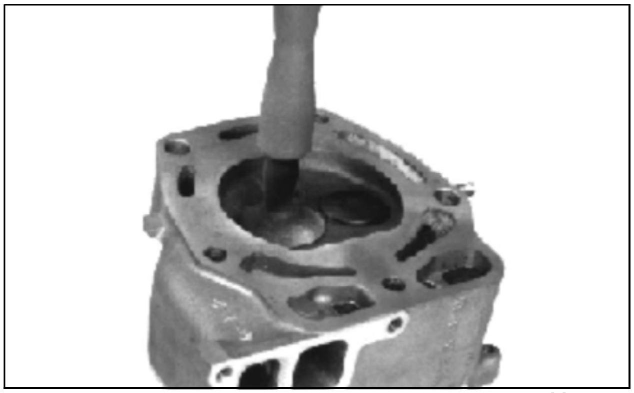
Valve Margin (D) (Minimum) . . . . . 0.050 mm (0.020 in.)

Valve Narrowing Angle (A) . . . . 30°

Lap Valves

If valve seat does not make proper contact, lap the valve into the seat:

1. Apply a small amount of fine lapping compound to face of valve.



M51714

2. Grip top of valve with a vacuum cup tool and turn valve to lap valve to seat.

3. Lift valve from seat every 8 to 10 strokes. Lap until a uniform ring appears around the surface the valve face.

CAUTION: Avoid Injury! Reduce compressed air to less than 210 kPa (2 bar) (30 psi) when using for cleaning purposes. Clear area of bystanders, guard against flying chips, and wear personal protection equipment including eye protection.

4. Wash all parts in solvent to remove lapping compound and dry parts with compressed air.

5. Check position of lap mark on valve face. Lap mark must be on or near the center of valve face.

6. Apply a light coat of clean engine oil to seat and valve to prevent rusting.

Crankcase Cover

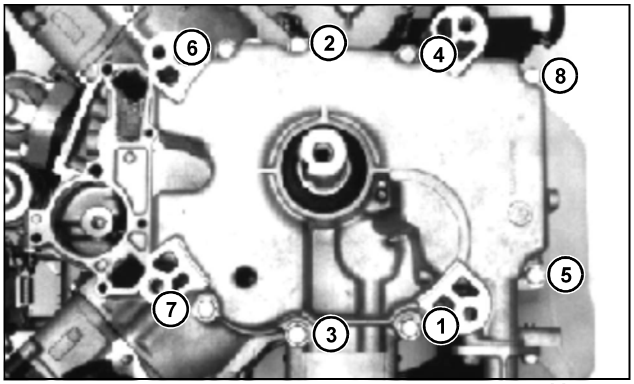
Removal/Installation:

1. Drain oil from crankcase. Capacity is approximately 1.8 L (1.9 qt) with filter.
2. Remove coolant pump. See "Coolant Pump" on page 161.
3. Remove eight cap screws, crankcase cover and gasket.
4. Clean crankcase and crankcase cover gasket surfaces.

Installation is done in the reverse order of removal.

NOTE: Do not force cover. Gears must mesh for proper positioning.

- Use new gasket for installation.



M51720

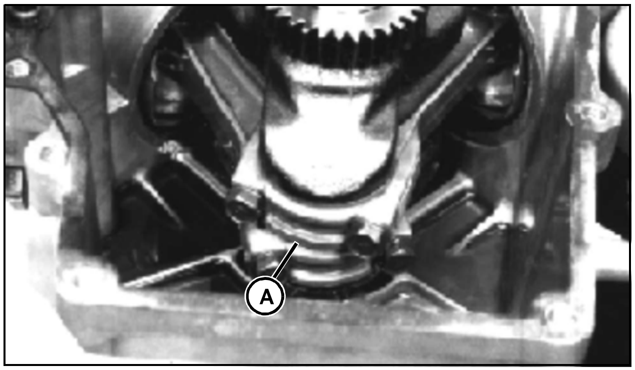
- Tighten mounting cap screws using the sequence shown to 21 N•m (186 lb-in.).
- Tighten oil drain plug to 25 N•m (221 lb-in.).

Piston and Connecting Rod

Removal:

NOTE: No. 1 cylinder is the right cylinder viewed from the flywheel. No. 2 cylinder is the left cylinder viewed from the flywheel.

1. Remove cylinder head. See "Cylinder Head and Valves" on page 164.
2. Remove crankcase cover. See "Crankcase Cover" on page 169.
3. Check cylinder bore for ridges which can cause piston damage if not removed. Remove ridge using a ridge reamer.
4. Turn crankshaft to expose connecting rod caps.



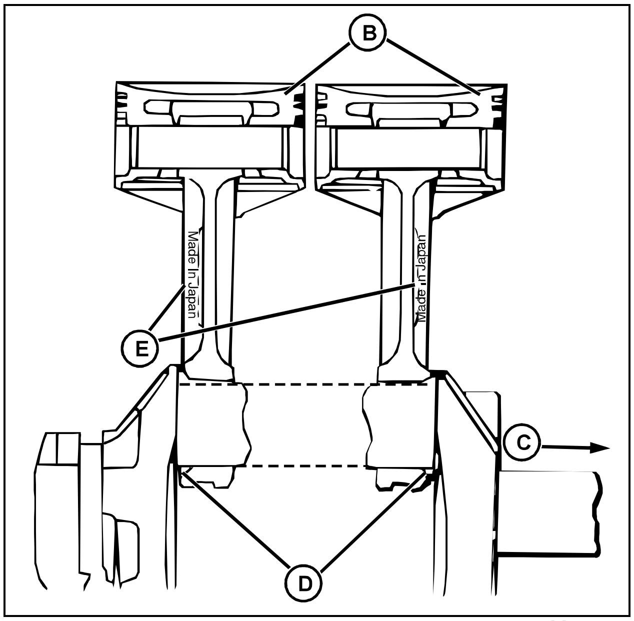
M51726

5. Remove connecting rod cap (A).
6. Push piston and connecting rod assembly from cylinder bore.
7. Disassemble and inspect all parts for wear or damage. See Disassembly and Inspection procedures below.

Installation:

1. Deglaze cylinder bore. See "Deglaze Cylinder Bore" on page 176.
2. Stagger piston ring end gaps 180° apart, but do not align with oil ring side rail end caps.
3. Apply a light film of oil to piston and rings. Compress rings with a ring compressor.

IMPORTANT: Avoid damage! Match mark (B) on pistons must face flywheel side (C). Large chamfer (D) of connecting rods must be against crankshaft web (opposite each other). Note: "MADE IN JAPAN" marks (E) on connecting rods.



M85631

4. Install piston and connecting rod assembly in cylinder

bore with arrow match mark on piston head facing the flywheel side of the engine.

5. Apply a light film of clean engine oil to cap bearing surface and cap screws. Install connecting rod cap with chamfer facing crank web. Tighten cap screws to 12 N•m (106 lb-in.).

6. Install crankcase cover. See “Crankcase Cover” on page 169.

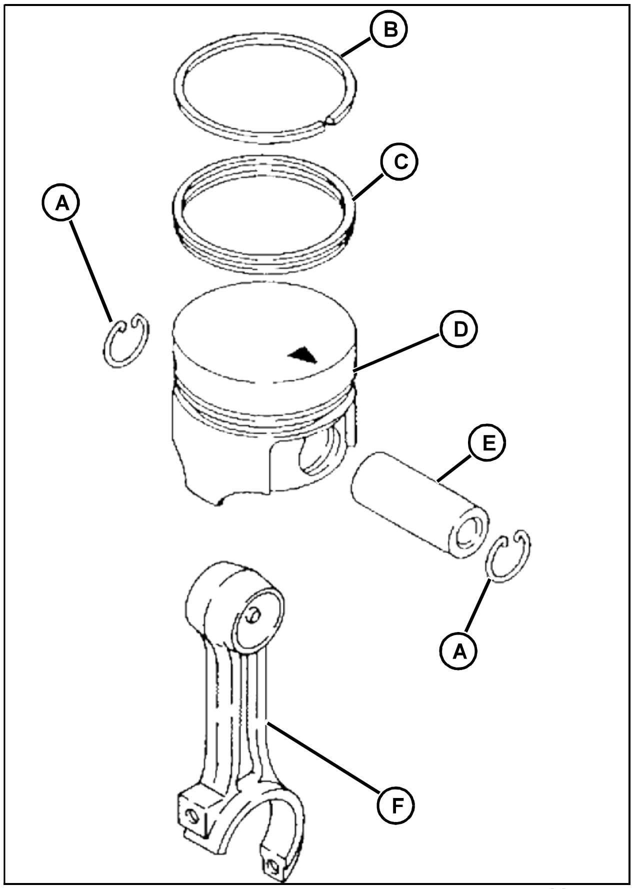
7. Install cylinder head. See “Cylinder Head and Valves” on page 164.

Disassembly:

IMPORTANT: Avoid damage! Keep parts together as a set.

- Analyze piston and piston ring wear.
- Mark each piston and connecting rod to aid in assembly.
- Remove piston rings using a piston ring expander.
- Inspect all parts for wear or damage. Replace as necessary. See "Inspection:" procedures below.

IMPORTANT: Avoid damage! DO NOT reuse piston pin retaining rings. Always use new for assembly.



M83419

A - Retaining Ring (Replace)
B - Compression Ring
C - Oil Ring with Expander
D - Piston
E - Piston Pin
F - Connecting Rod

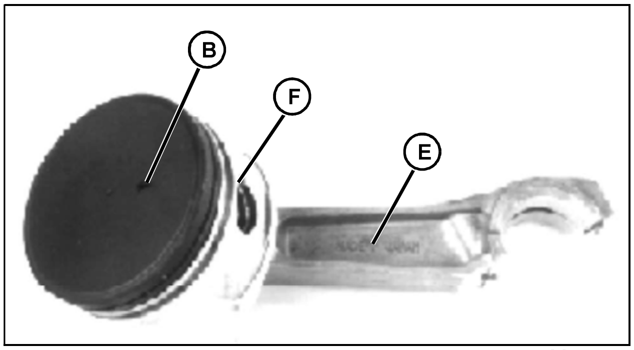
Assembly:

- Apply a thin film of clean engine oil to piston pin and connecting rod bearing during assembly.

NOTE: With pistons installed, No. 1 piston is designated by the large chamfer on connecting rod facing toward flywheel.

No. 2 piston is designated by the large chamfer on the connecting rod facing away from flywheel.

The arrow match mark on both piston heads should point toward the flywheel.



M38111

No. 1 Piston Shown

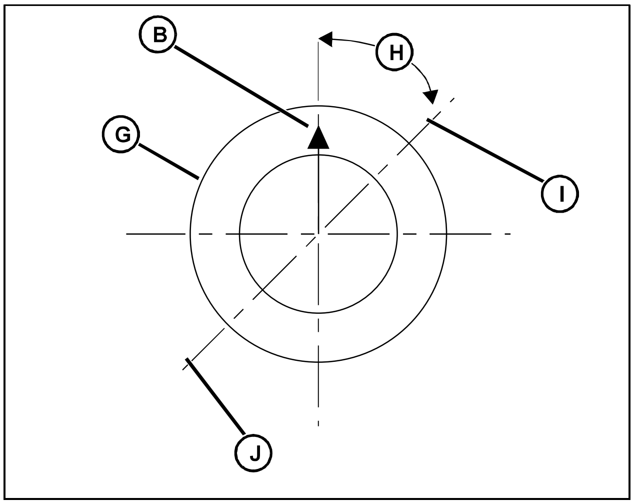
1. Assemble pistons to connecting rods:
   - No. 1 piston: Align arrow match mark (B) on piston head with “MADE IN JAPAN” (E) on connecting rod.
   - No. 2 piston: Align arrow match mark on piston head opposite "MADE IN JAPAN" on connecting rod.

IMPORTANT: Avoid damage! DO NOT reuse piston pin retaining rings.

Retaining ring gap must not align with notch (F) at end of piston pin bore.

2. Install piston pin with new retaining rings.

3. Before installing rings on piston (G), check ring end gap in cylinder bore. Note 45× angle (H) from gap of upper side rail of oil ring (I) in relation to gap of compression ring and lower side rail of oil ring (J).



M83420

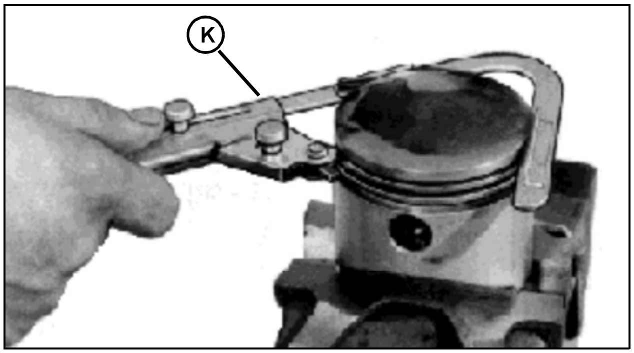
4. Install oil control and compression rings:

- Oil ring: Install spacer, then side rails. Align side rail end gaps 180× apart in the position shown.
- Install compression ring in groove with letter mark facing up. Ring should turn freely in groove. Turn ring until gap is positioned as shown.

Piston Inspection:

IMPORTANT: Avoid damage! DO NOT use a caustic cleaning solution or a wire brush to clean piston.

1. Remove all deposits from the piston.



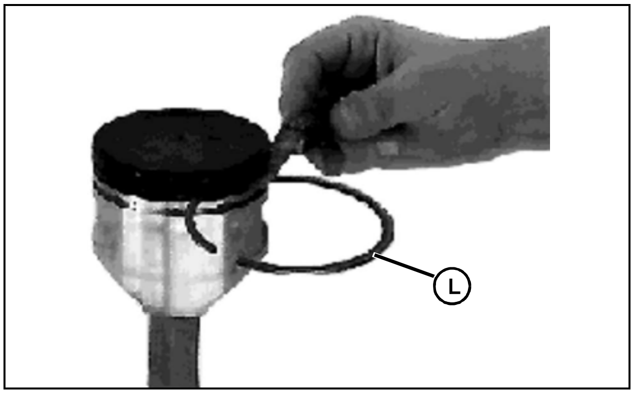
M29946

2. Clean carbon from piston ring grooves with a ring groove cleaner (K). If cleaning tool is not available, break an old ring and use it to carefully clean groove.

3. Check that all oil return passages in grooves are open.

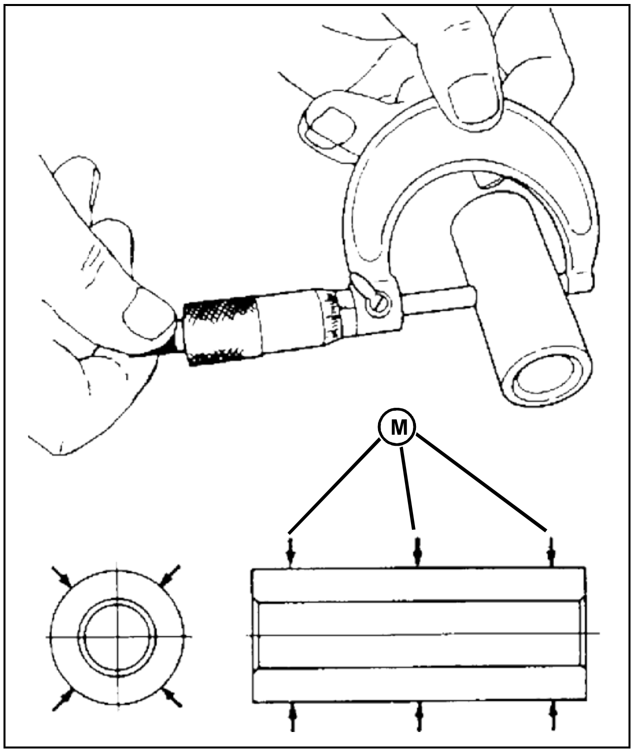
4. Inspect piston for scoring or fractures. Replace piston if damaged.

NOTE: Oil control rings are not measured.



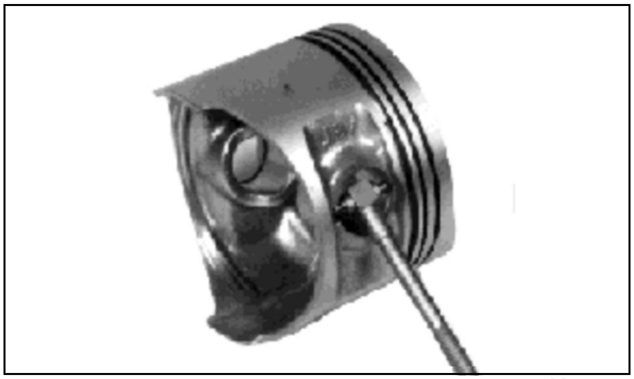
M38102

5. Using a new piston ring (L) and feeler gauge, check top two ring grooves for wear, at several points around piston. Replace piston if clearance is greater than 0.10 mm (0.004 in.). Oil ring groove is not measured, use visual check only.



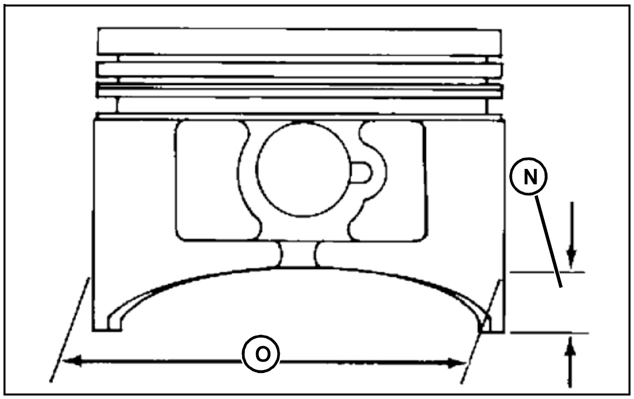
M82050A

6. Measure piston pin diameter at six places (M). Replace pin if measurement is less than 15.98 mm (0.629 in.).



M80427

7. Measure piston pin bore diameter in piston. Replace piston if measurement is greater than 16.04 mm (0.631 in.).



M53956

8. Measure piston OD (O) perpendicular to piston pin at distance “A” (N).

NOTE: If the engine has had a previous major overhaul, oversize pistons and rings may have been installed. Pistons and rings are available in oversize - 0.50 mm (0.020 in.).

9. Measure cylinder bore diameter.

10.Subtract piston OD measurement from cylinder bore measurement to determine piston-to-cylinder bore clearance.

11.Replace piston and/or rebore cylinder block if not within 0.015 - 0.150 mm (0.0006 - 0.006 in.).

Piston Specifications:

Distance "A" . . . . 13.5 mm (0.531 in.)

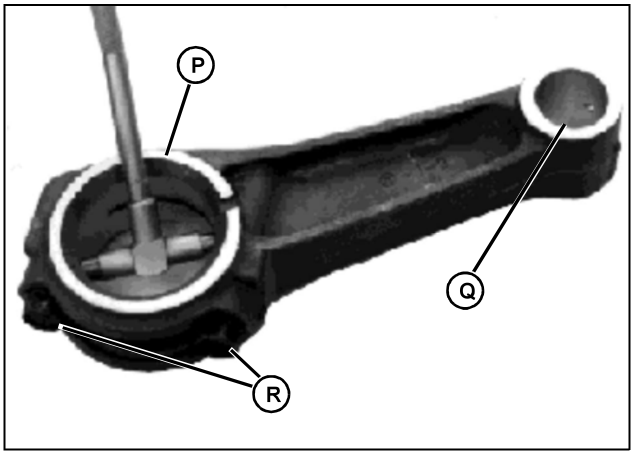
Piston OD

Standard . . . . . 66.950 - 66.965 mm (2.6358 - 2.6364 in.)
Oversize 0.50 mm
(0.020 in.). . . . . 67.45 - 67.465 mm (2.655 - 2.656 in.)

Connecting Rod Inspection:

1. Analyze crankshaft and connecting rod wear.

2. Clean and inspect rod. Replace if scored.



M50066

3. Install connecting rod cap. Tighten cap screws (R) to 12 N•m (106 lb-in.).

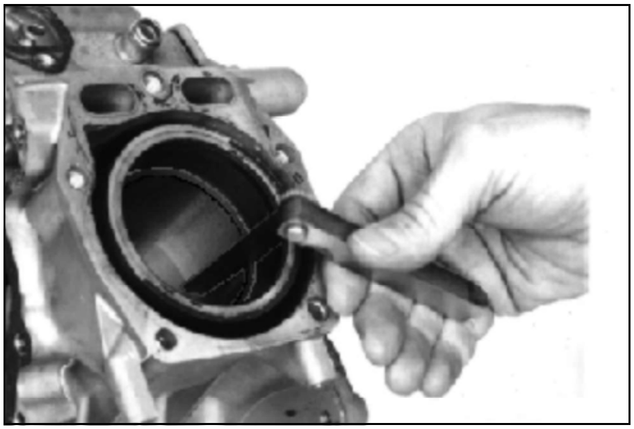
4. Measure connecting rod crankshaft bearing inside diameter (P) and piston pin bearing inside diameter (Q). Replace connecting rod if either measurement is greater than specifications.

Connecting Rod Bearing ID (Maximum):

Crankshaft Bearing ID . . . . 31.06 mm (1.223 in.)
Piston Pin Bearing ID
(Maximum) . . . . 16.05 mm (0.632 in.)

Piston Rings Inspection:

NOTE: Oil control ring gap is not measured.



M53962

1. Check piston ring end gap:

   - Install compression rings individually using a piston to position it squarely in bore approximately 25.4 mm (1.0 in.) down from top of cylinder.
   - Check end gap with feeler gauge. Replace ring if end gap is greater than 1.00 mm (0.040 in.).

Camshaft and Tappets

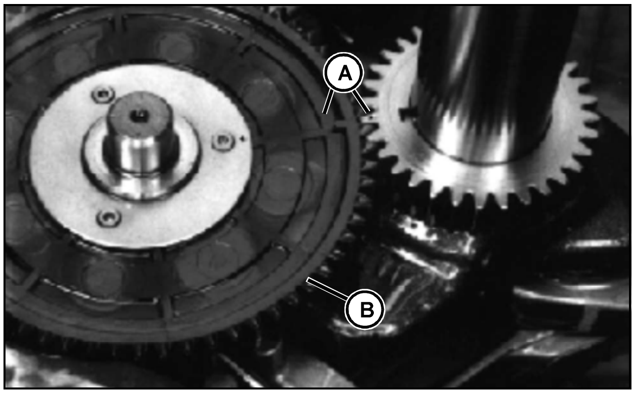
Removal and Installation:

1. Remove fuel pump. See “Fuel Pump” on page 158.

2. Remove rocker arm assemblies. See “Rocker Arm Assembly” on page 163.

3. Remove crankshaft cover. See “Crankcase Cover” on page 169.

IMPORTANT: Avoid damage! Align timing marks (A) to prevent damage to tappets when removing camshaft (B).

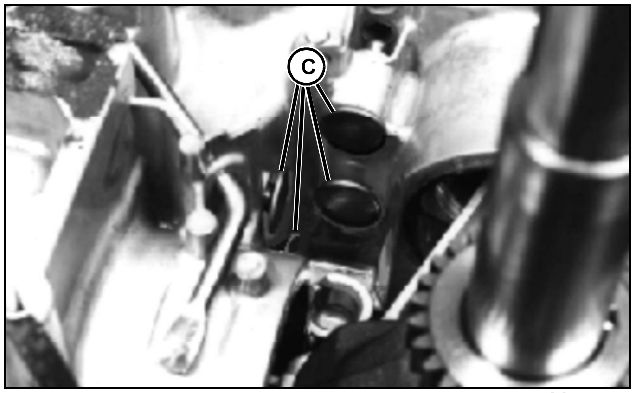


M51721

4. Rotate crankshaft until timing marks align.

5. Remove and inspect camshaft. See "Inspection:" procedures below.

NOTE: Mark tappets (C) so they can be installed in their original guides during assembly.



M53975

6. Remove and inspect tappets (C) for wear or damage. Replace if necessary.

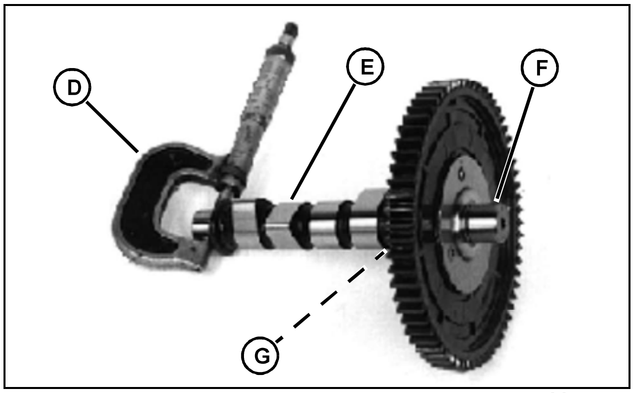
Installation is done in the reverse order of removal.

- Align timing marks when installing camshaft.

Inspection:

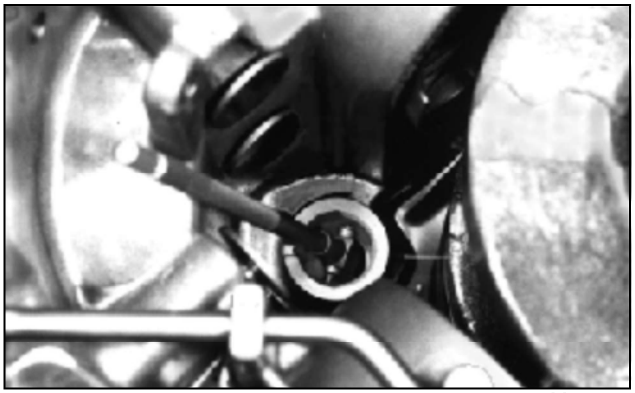
1. Inspect camshaft for worn or broken teeth.

2. Check for loose rivets holding the gear to camshaft. Replace camshaft if loose.



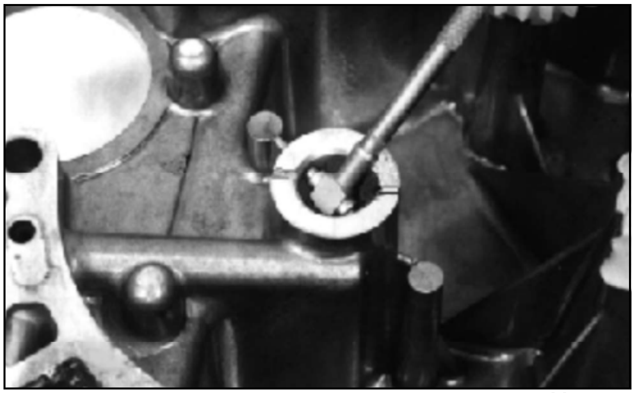
M51722

3. Measure flywheel side journal (D), PTO side journal (F), cam lobe (E) height, and fuel pump lobe (G). Replace camshaft if any measurement is less than specifications.



M51723

Camshaft Bearing (Crankcase)



M51724

Camshaft Bearing (Crankcase Cover)

4. Measure camshaft bearings in crankcase. Replace block if diameter is greater than 14.07 mm (0.554 in.).

5. Measure camshaft bearings in crankcase cover. Replace cover if diameter is greater than 14.05 mm (0.553 in.).

Camshaft Specifications (Minimum):

PTO Side Journal	**13.91 mm (0.548 in.)**
Flywheel Side Journal	**13.91 mm (0.548 in.)**
Cam Lobe Height	**24.43 mm (0.962 in.)**
Fuel Pump Lobe Height	**19.50 mm (0.760 in.)**

Crankshaft and Main Bearings

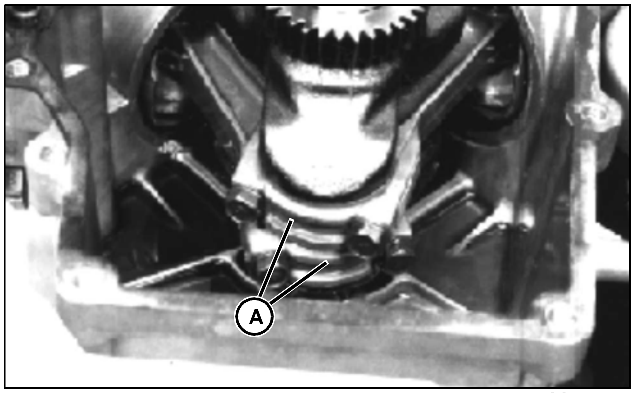
Removal/Installation:

1. Remove flywheel. See “Flywheel Removal and Installation” on page 163.

2. Remove camshaft. See “Camshaft and Tappets” on page 173.

IMPORTANT: Avoid damage! Connecting rod caps must be installed on the same connecting rods they were removed from.

3. Mark connecting rod caps to aid in installation.



M51726

4. Remove cap screws and connecting rod caps (A), and push pistons to top of cylinder.

5. Remove crankshaft.

6. Inspect crankshaft for wear or damage. See "Inspection:" procedures below.

Installation is done in the reverse order of removal.

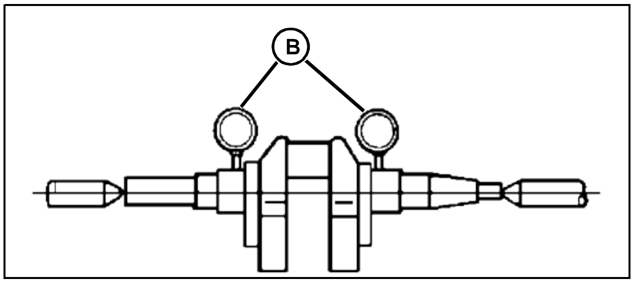
- Cover keyway on flywheel end of crankshaft with tape to prevent seal damage when installing crankshaft.
- Apply a light film of clean engine oil on crankshaft bearing surfaces before installation.
- Pack oil seals with lithium base grease.
- Install connecting rod caps.
- Tighten connecting rod cap screws to 12 N•m (106 lb-in.).

Inspection:

1. Check crankshaft and connecting rod for wear.

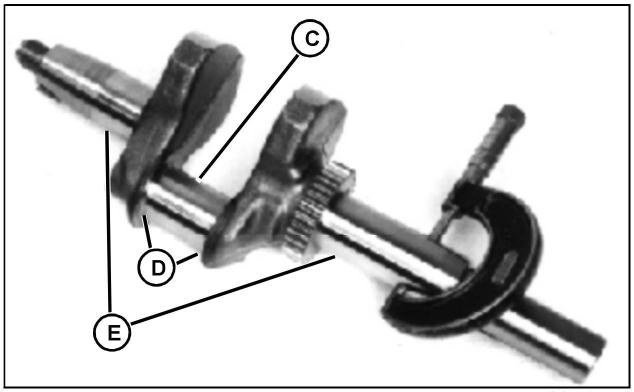
IMPORTANT: Avoid damage! A bent crankshaft must be replaced; it cannot be straightened.

2. Clean and inspect crankshaft. Replace if scratched, damaged or worn beyond specifications.



M80432

3. Place crankshaft into an alignment jig and slowly rotate crankshaft. Use dial indicators (B) to measure maximum Total Indicated Runout (TIR). If runout exceeds 0.05 mm (0.002 in.), replace crankshaft.

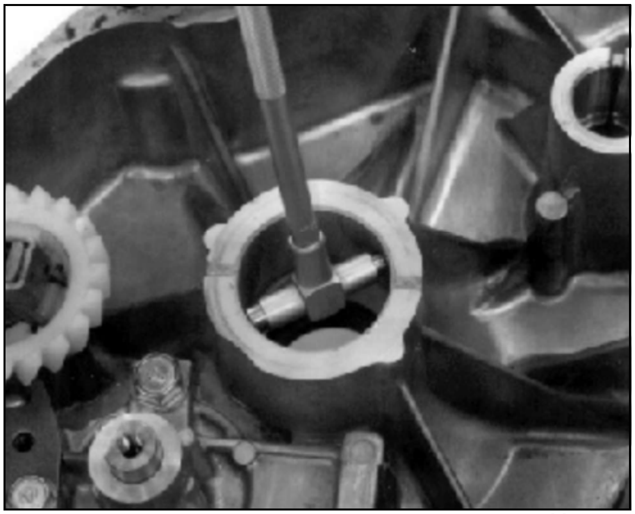


M51729

4. Measure main bearing journal diameters (E). If either journal OD is less than 29.92 mm (1.178 in.), replace crankshaft.

5. Measure connecting rod journal diameter (C). If journal is less than 30.93 mm (1.218 in.), replace crankshaft. Inspect journal radii (D) for cracks.

If any journal diameter is less than specifications, replace crankshaft.



Crankcase Cover Shown

6. Measure crankshaft main bearing diameter in crankcase and crankcase cover. Replace crankcase or crankcase cover if bearing ID is greater than 30.09 mm (1.185 in.).

Crankshaft Oil Seals

Replacement:

IMPORTANT: Avoid damage! DO NOT scratch machined surface of bearings when removing seals.

Flywheel End: Remove crankshaft. See "Crankshaft and Main Bearings" on page 174.

PTO End: Remove crankshaft cover. See "Crankcase Cover" on page 169.

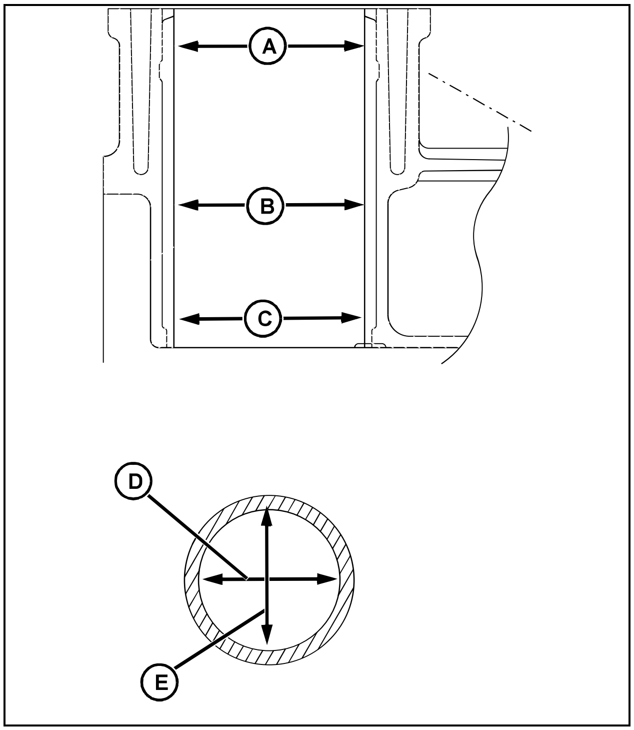
- Remove worn or damaged seals using a screwdriver. DO NOT damage machined surfaces.
- Install seals with lip toward inside of engine using a driver set. Press in seals until flush with flange surface.
- Pack lithium based grease inside lips of seals.

Cylinder Block

Inspection:

1. Clean block and check for cracks.

NOTE: Cracks not visible to the eye may be detected by coating the suspected area with a mixture of 25% kerosene and 75% light engine oil. Wipe area dry and immediately apply coating of zinc oxide dissolved in wood alcohol. If crack is present, coating becomes discolored at the defective area. Replace block if any cracks are found.



2. Measure cylinder bore diameter at three positions:
   - Top (A)- 10 mm (0.3937 in.) from top of block.
   - Middle (B)- 55 mm (2.165 in.) from top of block.
   - Bottom (C)- 10 mm (0.3937 in.) from bottom of cylinder.

At these three positions, measure in both directions along crankshaft centerline (E) and direction of crankshaft rotation (D).

NOTE: If the engine has had a previous major overhaul, oversize pistons and rings may have been installed. Pistons and rings are available in oversize - 0.50 mm (0.020 in.).

3. If cylinder bore exceeds wear limit, rebore cylinder or replace cylinder block. See "Rebore Cylinder Block" below.

NOTE: If cylinders are rebored, oversize pistons and rings must be installed.

Cylinder Bore ID:

Standard Size . . . 66.980 - 67.000 mm (2.637 - 2.638 in.)
Wear Limit. 67.06 mm (2.639 in.)
Oversized . . . . . . 67.480 - 67.500 mm (2.656 - 2.657 in.)
Wear Limit. . . . . 67.560 mm (2.659 in.)

Deglaze Cylinder Bore

1. Deglaze cylinder bore using a rigid hone with a coarse grit stone initially and fine grit stone for the final finish.

2. Use hone as instructed by manufacture to obtain a 40× crosshatch pattern.

IMPORTANT: Avoid damage! DO NOT use gasoline, kerosene, or commercial solvents to clean cylinder bores. Solvents will not remove all abrasives from cylinder walls.

3. Clean cylinder walls using clean white rags and warm soapy water. Continue to clean cylinder until white rags show no discoloration.

4. Dry cylinder and apply a light coat of engine oil.

Rebore Cylinder Block

IMPORTANT: Avoid damage! Check stone for wear or damage. Use correct stone for the job.

NOTE: The cylinder block can be rebored to use oversize pistons and rings - 0.50 mm (0.020 in.). Have a reliable repair shop rebore the block, or use a drill press and honing tool. Rebore cylinder with honing tool to an initial (coarse grit stone) and a final (fine grit stone) bore according to below specifications. Align center of bore to drill press center.

1. Lower and raise hone until end extends 20 - 25 mm (0.75 - 1.0 in.) past ends of cylinder.

2. Adjust hone stones until they contact narrowest point of cylinder walls.

3. Coat inside of cylinder with honing oil. Turn hone by hand. Adjust if too tight.

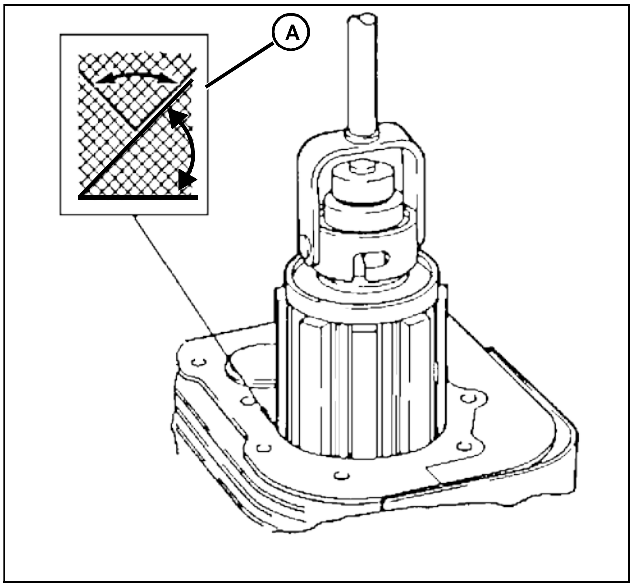
4. Run drill press between 200 - 250 rpm. Move hone up and down in cylinder approximately 20 times per minute.

NOTE: Measure bore when cylinder is cool.

5. Stop press and check cylinder diameter.

NOTE: Finish should not be smooth. It should have a 40 - 60° cross-hatch pattern (A).

6. Check bore for size, taper and out-of-round.



M82412A

7. If cylinder bore exceeds wear limit, rebore cylinder or replace block.

8. Hone the cylinder an additional 0.007 - 0.009 mm (0.0003 - 0.0004 in.) for final bore specifications. This allows for 0.020 mm (0.0008 in.) shrinkage when cylinder cools.

IMPORTANT: Avoid damage! DO NOT use gasoline, kerosene, or commercial solvents to clean cylinder bores. Solvents will not remove all abrasives from cylinder walls.

9. Clean cylinder walls using clean white rags and water. Continue to clean cylinder until white rags show no discoloration.

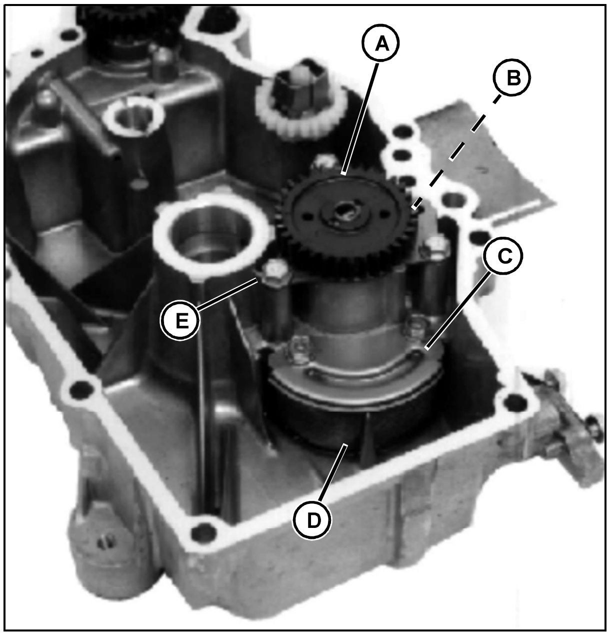
10.Dry cylinder. Apply a light coat of clean engine oil.

Oil Pump

Disassembly and Assembly:

1. Remove crankcase cover. See “Crankcase Cover” on page 169.

IMPORTANT: Avoid damage! Oil pressure relief valve spring will be loose when oil pump assembly is removed.



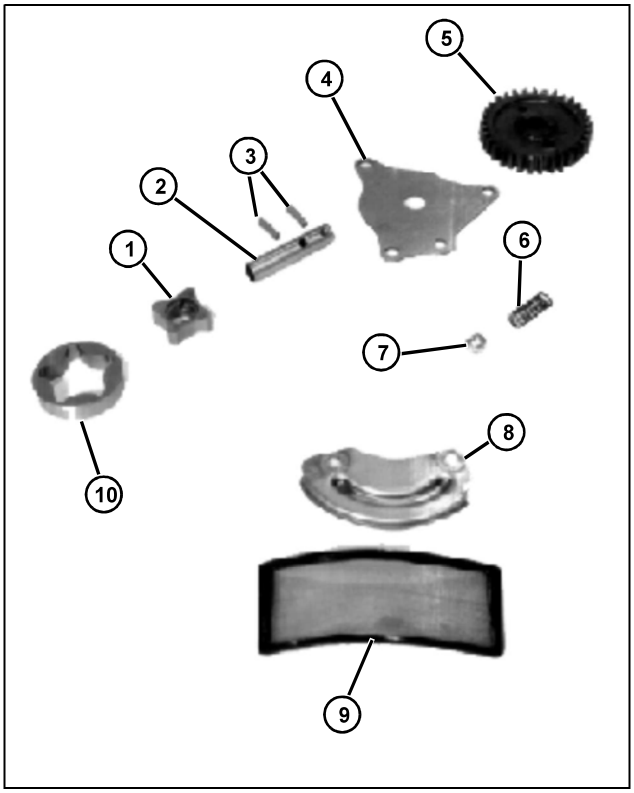
M82907

2. Remove three cap screws (E) and oil pump assembly.
3. Remove gear (A), and relief spring and ball (B).
4. Remove oil pick-up screen (D) and cover (C).
5. Inspect all parts for wear. See "Inspection:" procedure below.

Assembly is done in the reverse order of disassembly.

- Fill rotor housing with engine oil for initial lubrication.
- Install oil pump assembly so that hole in the plate is centered over relief valve.
- Tighten oil pump cap screws (E) to 7.8 N•m (69 lb-in.).

Inspection:

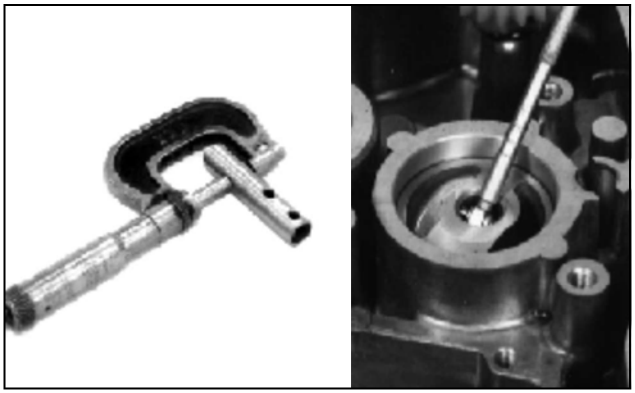


M82998

A - Inner Rotor
B - Rotor Shaft
C - Pin (2 used)
D - Cover
E - Gear
F - Relief Valve Spring
G - Relief Valve Ball
H - Oil Pick-Up Cover
I - Oil Pick-Up Screen
J - Outer Rotor

Inspect all parts for wear or damaged. Replace parts if necessary.

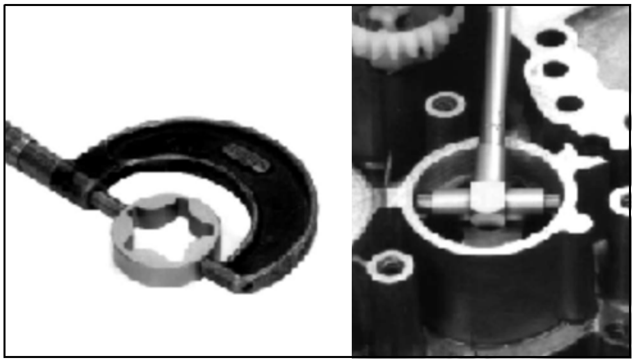
NOTE: Rotors and rotor shaft are replaced as a kit. If any of the parts show signs of wear or are scored, replace.



M53968 / M53969

1. Measure rotor shaft diameter. If shaft OD is less than 10.92 mm (0.430 in.), replace both shaft and outer rotor.

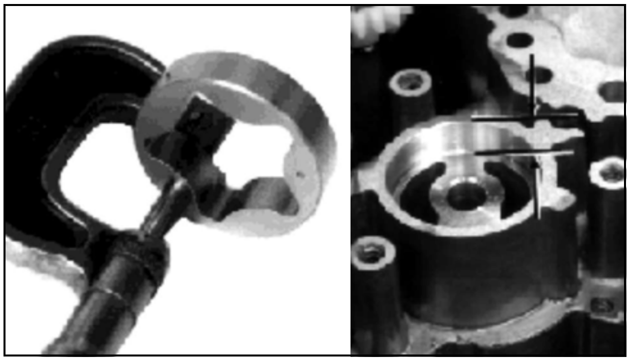
2. Measure rotor shaft bearing. If bearing IDs are greater than 11.07 mm (0.436 in.), replace crankcase cover.



M53970 / M53971

3. Measure outside diameter of outer rotor. If OD is less than 40.43 mm (1.592 in.), replace both outer rotor and shaft.

4. Measure inside diameter of rotor bearing. If ID is greater than 40.80 mm (1.606 in.), replace crankcase cover.

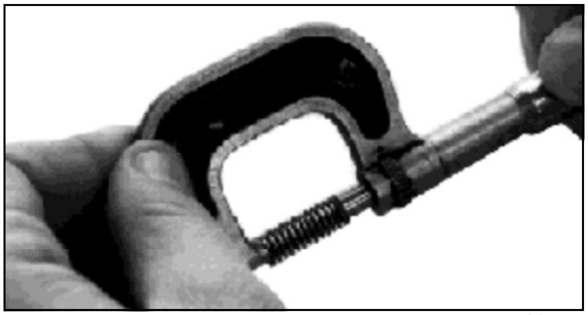


M80015 / M82908

5. Measure thickness of outer rotor. If thickness is less than 9.83 mm (0.387 in.), replace rotor.

6. Measure outer rotor bearing depth. If depth is greater than 10.23 mm (0.403 in.), replace pump housing.

7. Measure inner and outer rotor clearance. If clearance is greater than 0.3 mm (0.012 in.), replace both rotors.



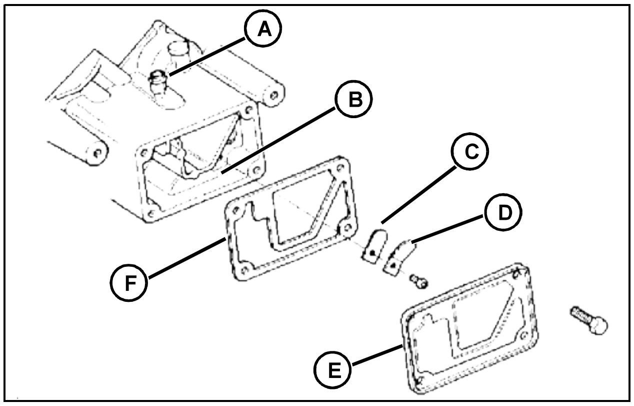
M50083

8. Measure relief valve spring. If free length is less than 19.0 mm (0.748 in.), replace spring.

Breather

Inspection:

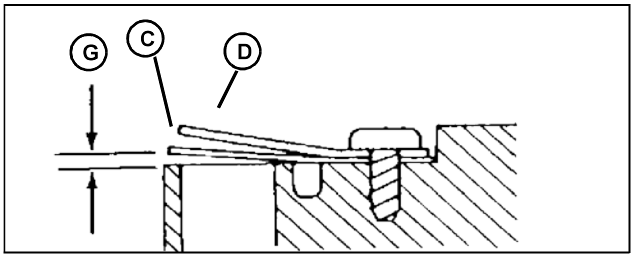
1. Remove flywheel. See “Flywheel Removal and Installation” on page 163.



M54277

2. Remove breather cover (E) and gasket (F). Discard gasket.

3. Check that drain hole (B) in bottom of breather chamber and air vent to intake (A) are open.



M51757

4. Inspect reed valve for breakage, hairline cracks or distortion; replace if necessary.

5. Inspect back plate (D) for damage or a rough contact surface; replace if necessary.

6. Check reed valve tip air gap. Gap should be 0.2 mm (0.008 in.). Replace reed valve (C) if gap (G) is greater than specifications.

Governor

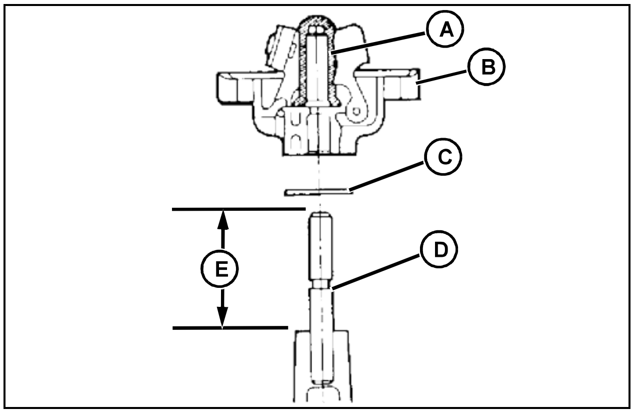
Inspection and Replacement:

1. Remove crankcase cover. See “Crankcase Cover” on page 169.

IMPORTANT: Avoid damage! Do not remove governor assembly or shaft unless damaged. Removal damages the assembly.

2. Inspect governor for wear or damage. Replace if necessary.

To replace governor:



M51762

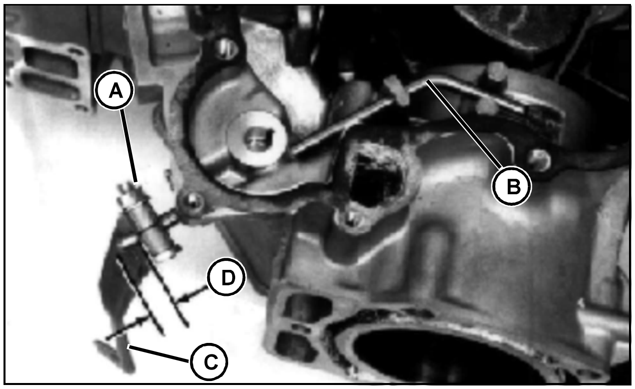
1. Use two screwdrivers to pry governor assembly and washer (C) from pin (D). DO NOT damage crankcase sealing surfaces.
   - If shaft is removed, press shaft back into block until it protrudes 32.2 - 32.8 mm (1.267 - 1.291 in.) (E).
   - Install sleeve (A) onto governor gear (B), properly engaging flyweights.
   - Install governor assembly onto shaft. Push down on assembly until it snaps into place. Check assembly for freedom of movement.

Governor Shaft

Inspection and Replacement:

NOTE: It is not necessary to remove governor shaft unless damaged.

1. Remove camshaft. See “Camshaft and Tappets” on page 173.



M51737

2. Inspect governor shaft (B) for wear or damage. Replace if necessary.

To replace governor shaft:

- Scribe a mark across shaft and lever (C) to aid in installation.
- Loosen nut (A) on lever.
- Remove lever and shaft.
- Install governor arm and align marks made during removal. Position lever 7 mm (0.276 in.) (D) from end of shaft.
- Tighten nut (A) to 7.8 N•m (69 lb-in.).

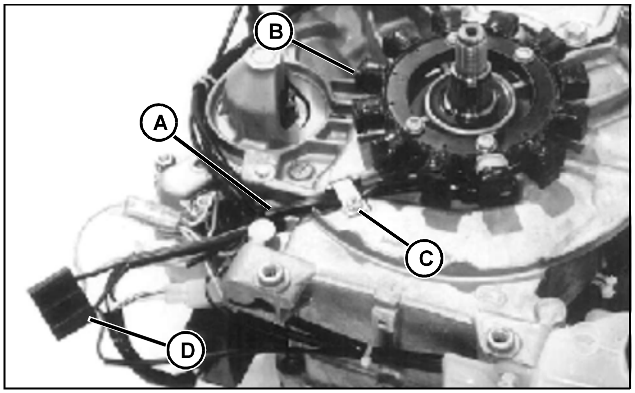
Governor Shaft Seal

Replacement:

1. Remove governor shaft.
2. Remove damaged seal using a screwdriver.
3. Install seal with lip toward engine using a driver set. Press in seal until 1.0 mm (0.040 in.) below crankcase surface.

Stator Removal and Installation

1. Remove flywheel. See “Flywheel Removal and Installation” on page 163.
2. Cut wire tie (A) from wiring harness.



M83422

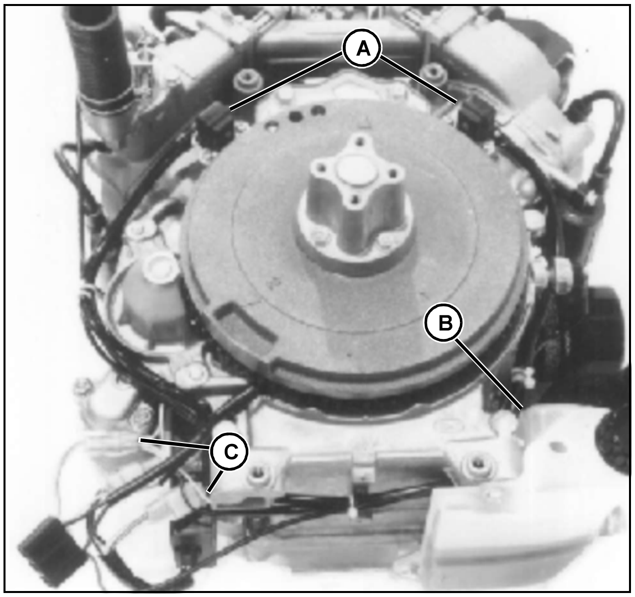
3. Remove stator wiring lead pins from connector (D).
4. Remove clamp (C).
5. Remove stator (B).

Installation is done in the reverse order of removal.

Pulser Coils

Replacement:

1. Remove cooling air duct. See “Cooling Air Duct” on page 160.
2. Cut wire ties from wiring harness. Note wire routing and location of wire ties for installation.



M83423

3. Remove pulser coils (A).
4. Disconnect wiring harness connectors (C).
5. Remove overflow reservoir (B), if necessary.

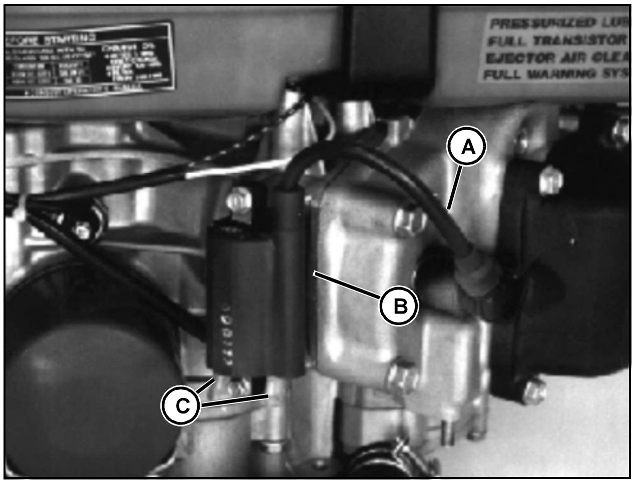
Installation is done in the reverse order of removal.

NOTE: Pulser coils are mounted in a fixed position. Air gap 0.35 - 1.13 mm (0.013 - 0.044 in.) and not adjustable.

- Install new wire ties where needed.

Ignition Coils

Replacement:

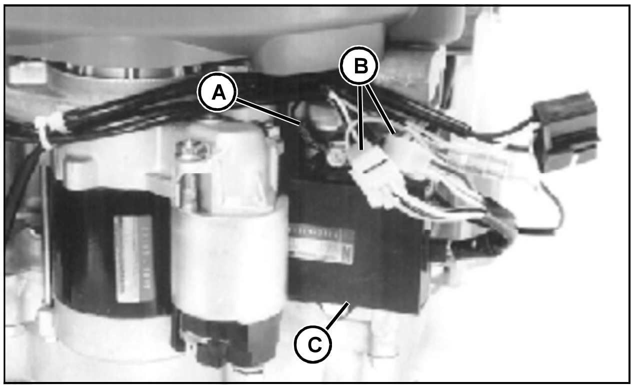


M51688

1. Disconnect wiring leads (C) and spark plug lead (A).
2. Remove cap screws and coil (B).

Installation is done in the reverse order of removal.

Ignition Module Replacement



M83424

1. Disconnect wiring connectors (B).
2. Remove cap screws and ignition module (C).

Installation is done in the reverse order of removal.

- When installing ignition module, put ground wire (A) under cap screw.

Starting Motor

Analyze Condition:

The starting motor overheats because of:

- Long cranking.
- Armature binding.

The starting motor operates poorly because of:

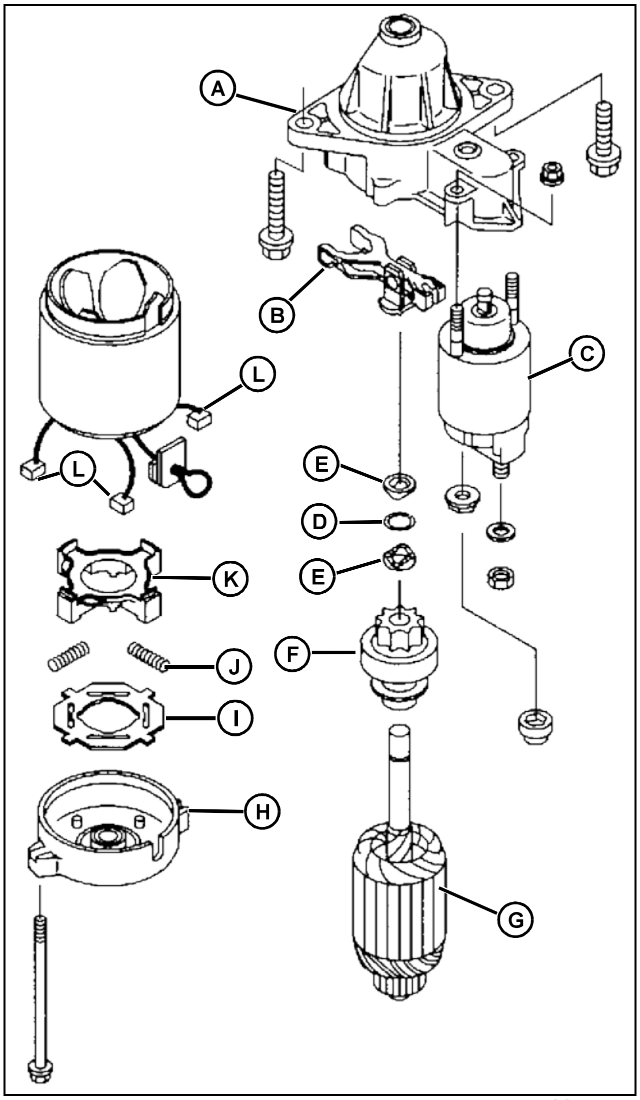
- Armature binding.
- Dirty or damaged starting motor drive.
- Badly worn brushes or weak brush springs.
- Excessive voltage drop in cranking system.
- Battery or wiring defective.
- Shorts, opens, or grounds in armature.

NOTE: Starting motor repair is limited to brushes, end caps, and starting motor drive. If housing or armature is damaged, replace starting motor.

Disassembly and Assembly:

1. Mark body and covers for correct alignment during reassembly.
2. Push pinion stopper (E) toward pinion (F) to remove retaining clip (D).
3. Inspect parts for wear or damage.
4. Test solenoid (C), starting motor armature (G) and brushes (O). See "Inspection/Test:" procedure below.

Assembly is done in the reverse order of disassembly.



M99583

A - Front Cover
B - Shift Lever
C - Solenoid
D - Retaining Clip
E - Pinion Stopper
F - Pinion
G - Armature
H - End Cover
I - Insulator
J - Brush Springs
K - Brush Holder
L - Brush

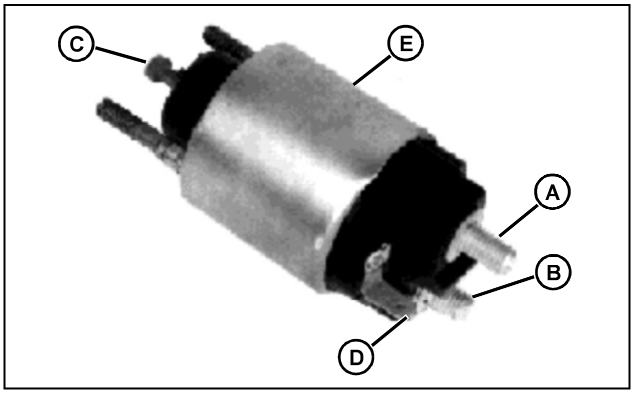
Apply a thin coat of multipurpose grease to:

- Sliding surfaces of armature and solenoid shift lever.
- Armature shaft spline.
- Points where shaft contacts cover.

Inspection/Test:

1. Measure field coil brush lengths. If any one brush length is less than 10.5 mm (0.413 in.), replace all four brushes.

2. Inspect brush springs for wear or damage. Replace if necessary.



M51705

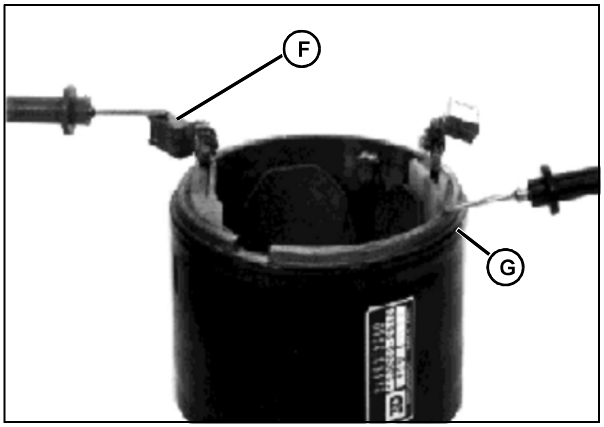
3. Test solenoid terminals (A and B) for continuity. There should be no continuity.

4. Depress switch arm (C). There should be continuity when arm is fully depressed.

5. Test for open circuits between terminal (B) and tang (D). There should be continuity.

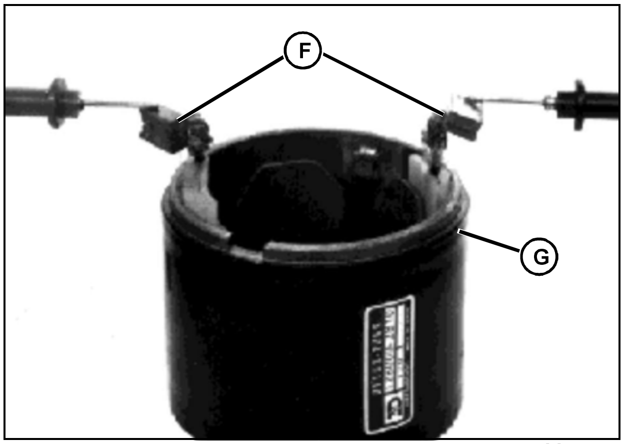
6. Test for open circuits between tang (D) and body (E). There should be continuity.

7. If solenoid fails any test, it is defective and must be replaced.



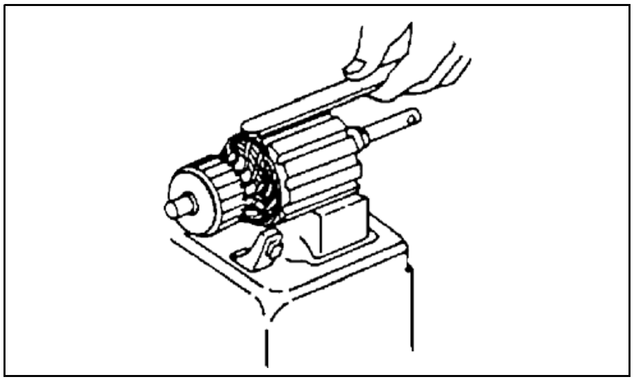
M50115

8. Test for grounded field winding. Touch one probe of tester to field coil brush (F) and the other probe to the field coil housing (G). Be sure the brush lead is not touching the frame. If there is continuity, the coil is grounded and the field coil housing must be replaced.



M50116

9. Test for open field coil. Touch one probe of tester to each field coil brush (F). If there is no continuity, the field coil is open and the field coil housing assembly (G) must be replaced.



M24861

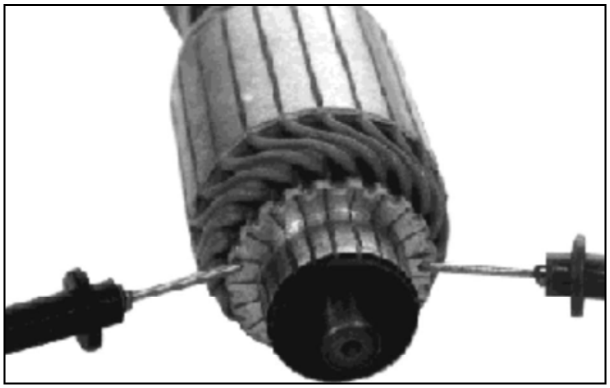
10. Locate short circuits by rotating armature on a growler while holding a hacksaw blade or steel strip on armature. The hacksaw blade will vibrate in area of short circuit.

NOTE: Shorts between bars are sometimes caused by dirt or copper between bars. Inspect for this condition.

11. If test indicates short circuited windings, clean the commutator of dust and fillings. Check armature again. If test still indicates short circuit, replace armature.

M50112

12.Test for grounded windings using an ohmmeter. Touch probes on each commutator bar. Armature windings are connected in parallel, so each commutator bar needs to be checked. If test shows continuity, a winding is grounded and the armature must be replaced.



M50113

13.Test for open circuited windings using an ohmmeter. Touch probes on each commutator bar. If test shows no continuity, there is an open circuit and armature must be replaced.

No-Load Amperage Draw and RPM Test

Reason:

To determine if starting motor is binding or has excessive amperage draw under no-load.

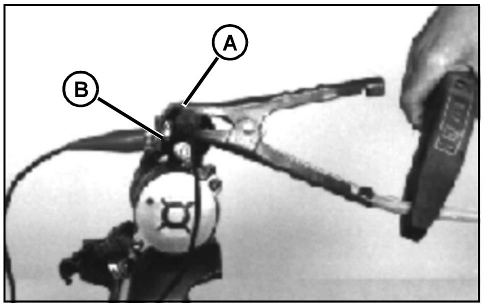
Test Equipment:

- JT05712 Current Gun
- JT03719 Photo Tachometer

Procedure:

IMPORTANT: Avoid damage! Complete this test in 20 seconds or less to prevent starting motor damage.

NOTE: Check that battery is fully charged and of proper size to ensure accuracy of test.



M45867

1. Connect jumper cables to battery.
2. Connect negative cable to starting motor body. Connect positive cable to terminal (A).
3. Use jumper wire to briefly connect terminals (A and B). Measure starting motor amperage and rpm. Maximum starting motor amperage is 50 amps at 5000 rpm.

Results:

- If amperage is out of specification, check for binding or seizing bearings, sticking brushes, dirty or worn commutator. Repair or replace starting motor.

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ENGINE - BRIGGS AND STRATTON SPECIFICATIONS

Specifications

General Specifications

Make	**Briggs & Stratton Vanguard V-Twin**
Model Number (LX288, SN -090000)	**350777-1154**
Horsepower	**13.4 kW (18 hp)**
Bore	**72 mm (2.83 in.)**
Stroke	**70 mm (2.76 in.)**
Displacement	**570 cm^3 (34.7 cu in.)**
Cylinders	**2 (V-twin)**
Stroke/Cycle	**4**
Valves	**Overhead Valves**
Lubrication	**Fully Pressurized**
Crankcase Oil Capacity	
w/o Oil Filter	**1.42 L (1.5 qt)**
w/ Oil Filter	**1.65 L (1.75 qt)**
Oil Filter	**Replaceable Full Flow, Spin-On Filter**
Cooling System	**Air Cooled with Oil Cooler**
Air Cleaner	**Paper Element with Foam Pre-cleaner**
Muffler	**Horizontal Discharge Below Frame**

Tests and Adjustments Specifications

Valve Clearance	**0.10 - 0.16 mm (0.004 - 0.006 in.)**
Valve Guide Depth	**0.7 mm (0.276 in.)**
Slow Idle	**1550 ± 100 rpm**
Fast Idle	**3350 ± 50 rpm**
Oil Pump Operating Pressure	**103 - 345 kPa (10 - 50 psi**
Spark Plug Type	**RC12YC**
Spark Plug Gap	**0.76 mm (0.030 in.)**
Ignition Coil Air Gap	**0.20 - 0.30 mm (0.008 - 0.012 in.)**

Repair Specifications

Valves:

Valve Guide Standard Dimension	**6.01 - 6.02 mm (0.236 - 0.237 in.)**
Valve Stem Standard Dimension	
Intake	**5.94 - 5.96 mm (0.234 - 0.235 in.)**
Exhaust	**5.94 - 5.95 mm (0.234 - 0.235 in.)**
Valve Stem Wear Limit	
Intake	**5.92 mm (0.233 in.)**
Exhaust	**5.91 mm (0.233 in.)**
Valve Seat Width	**1.2 - 1.6 mm (0.047 - 0.063 in.)**
Valve Margin (Minimum)	**0.4 mm (0.016 in.)**
Valve Face Angle	**45°**
Valve Seat Narrowing Angle	**30°**

Cylinder Bore, Pistons and Rings:

Cylinder Bore Standard Dimension	**72 - 72.02 mm (2.835 - 2.836 in.)**

Wear Limit	**72.065 mm (2.837 in.)**
Piston Pin Standard Dimension	**17.07 mm (0.672 in.)**
Wear Limit	**17.06 mm (0.671 in.)**
Piston Pin Bore Standard Dimension	**17.10 mm (0.673 in.)**
Wear Limit	**17.12 mm (0.674 in.)**
Ring End Gap Standard Dimension	**0.20 - 0.40 mm (0.008 - 0.016 in.)**
Wear Limit	**0.76 mm (0.030 in.)**
Compression Ring Groove Wear Limit (New Ring Installed)	**0.10 mm (0.004 in.)**
Oil Ring Groove Clearance Wear Limit (New Ring Installed)	**0.20 mm (0.008 in.)**

Connecting Rod and Crankshaft:

Connecting Rod Crankpin Standard Dimension	**37.06 - 37.08 mm (1.459 - 1.460 in.)**
Wear Limit	**37.12 mm (1.461 in.)**
Connecting Rod Piston Pin Bearing Std. Dimension	**17.10 mm (0.673 in.)**
Wear Limit	**17.12 mm (0.674 in.)**
Crankshaft PTO Journal Standard Dimension	**34.96 - 34.97 mm (1.376 - 1.377 in.)**
Wear Limit	**34.92 mm (1.375 in.)**
Crankshaft Magneto Journal Standard Dimension	**34.99 - 35.01 mm (1.377 - 1.378 in.)**
Wear Limit	**34.95 mm (1.376 in.)**
Magneto Bearing Standard Dimension	**35.02 - 35.06 mm (1.379 - 1.3805 in.)**
Wear Limit	**35.12 mm (1.383 in.)**
PTO Bearing Standard Dimension	**35.04 - 35.05 mm (1.379 - 1.380 in.)**
Wear Limit	**35.07 mm (1.381 in.)**
Crankpin Standard Dimension	**37.0 - 37.02 mm (1.456 - 1.457 in.)**
Wear Limit	**36.95 mm (1.455 in.)**
Crankshaft End Play	**0.05 - 0.58 mm (0.002 - 0.023 in.)**
Cam Gear PTO Journal Standard Dimension	**19.94 - 19.96 mm (0.785 - 0.786 in.)**
Wear Limit	**19.92 mm (0.784 in.)**
Cam Gear Magneto Journal Standard Dimension	**15.95 - 15.97 mm (0.628 - 0.629 in.)**
Wear Limit	**15.93 mm (0.627 in.)**
Cam Lobe Standard Dimension	**30.33 - 30.53 mm (1.194 - 1.202 in.)**
Wear Limit	**30.25 mm (1.191 in.)**
Cam Bearing (Magneto Side) Standard Dimension	**16 - 16.025 mm (0.630 - 0.631 in.)**
Wear Limit	**16.08 mm (0.633 in.)**
Cam Bearing (PTO Side) Standard Dimension	**20 - 20.02 mm (0.787 - 0.788 in.)**
Wear Limit	**20.04 mm (0.789 in.)**

Torque Specifications

Alternator to Cylinder Block	**2.2 N•m (20 lb-in.)**
Air Cleaner Base to Carburetor	**7 N•m (65 lb-in.)**
Connecting Rod Cap Screws	**11 N•m (100 lb-in.)**
Crankcase Cover	**17 N•m (150 lb-in.)**
Cylinder Head Cap Screws	**19 N•m (165 lb-in.)**
Cylinder Shield	**7 N•m (65 lb-in.)**
Exhaust Manifold	**17 N•m (150 lb-in.)**
Flywheel Nut	**175 N•m (125 lb-ft)**
Fuel Shutoff Solenoid	**5 N•m (45 lb-in.)**
Governor Lever Locknut	**8 N•m (70 lb-in.)**

ENGINE - BRIGGS AND STRATTON SPECIFICATIONS

Intake Manifold	**16 N•m (140 lb-in.)**
Ignition Armature Mounting Screws	**2.8 N•m (25 lb-in.)**
Oil Breather Mounting Bolt	**3 N•m (30 lb-in.)**
Oil Filter Adaptor Mounting Bolts	**7 N•m (65 lb-in.)**
Oil Pump Mounting Screws	**7 N•m (65 lb-in.)**
PTO Clutch to Engine Mounting Cap Screw	**75 N•m (55 lb-ft)**
Rocker Arm Adjustment Locknut	**7 N•m (65 lb-in.)**
Rocker Arm Studs	**11 N•m (100 lb-in.)**
Spark Plug	**20 N•m (180 lb-in.)**
Valve Cover Nuts	**3 N•m (25 lb-in.)**

Special or Essential Tools

Order tools according to information given in the U.S. SERVICEGARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

Special or Required Tools

Tool Name	Tool No.	Tool Use
Flywheel Puller	JDG640	Use to remove and install the flywheel on models with electrical outlet.

Diagnostics

Engine Diagnostics

CAUTION: Avoid Injury! The engine may start to rotate at any time. Keep hands away from moving parts when testing.

NOTE: To test specific electrical components, see Electrical Section and refer to either Diagnostics or Tests & Adjustments for further guidance.

Test Conditions:

- Operator On Seat
- PTO Switch In Off Position
- Brake On

Symptom: Engine Doesn't Crank

(1) Are battery cables loose or dirty?

Yes - Tighten or clean.

No - Go to next step.

(2) Is battery fully charged? See "Battery Voltage and Specific Gravity Test" on page 330 in the Electrical section.

No - Charge battery. See "Battery - Charge" on page 331 in the Electrical section.

Yes - Go to next step.

(3) Is key switch working correctly?

Yes - Go to next step.

No - Test switch. See "Cranking Circuit Operation" on page 277 in the Electrical section. Replace as needed.

(4) Has engine seized?

Yes - See Engine Repair Section.

No - Go to next step.

(5) Is starting motor or solenoid defective?

Yes - Repair or replace. See "Starting Motor Solenoid Test" on page 335 or "Starting Motor No-Load Amperage & RPM Tests" on page 336 in the Electrical section.

Symptom: Engine Cranks But Does Not Start

(1) Are battery cables loose or dirty?

Yes - Tighten or clean.

Symptom: Engine Cranks But Does Not Start

No - Go to next step.

(2) Is battery fully charged?

No - Charge battery.

Yes - Go to next step.

(3) Is switch position improper? See "Cranking Circuit Operation" on page 277 in the Electrical section.

Yes - Reset switch. See "Cranking Circuit Operation" on page 277 in the Electrical section.

No - Go to next step.

(4) Is air cleaner dirty?

Yes - Clean or replace. See "Air Cleaner Removal and Installation" on page 203.

No - Go to next step.

(5) Are spark plugs loose/dirty?

Yes - Clean or replace and tighten to specifications.

No - Go to next step.

(6) Is fuel old or contaminated?

Yes - Replace.

No - Go to next step.

(7) Are fuel filter/lines clogged?

Yes - Replace or clean.

No - Go to next step.

(8) Is fuel shutoff solenoid defective? See "Fuel Shutoff Solenoid Test" on page 197.

Yes - Replace.

No - Go to next step.

(9) Is fuel pump defective?

Yes - Replace.

No - Go to next step.

(10) Is ignition coil air gap adjusted properly? See "Ignition Armature Air Gap Adjustment" on page 202.

No - Adjust. See "Ignition Armature Air Gap Adjustment" on page 202.

Yes - Go to next step.

(11) Is carburetor adjusted properly, clean? See "Carburetor Adjustment" on page 199.

Symptom: Engine Cranks But Does Not Start

No - Adjust or clean. See “Carburetor Adjustment” on page 199.

Yes - Go to next step.

(12) Is magneto kill circuit grounded - shorted? See “Ignition Circuit Diagnosis - LX255, LX266, LX277 and LX288” on page 284 or “Ignition Circuit Diagnosis - LX279” on page 289 in the Electrical section.

Yes - Repair as needed.

No - Go to next step.

(13) Does engine lack compression? See “Compression Test” on page 197.

Yes - Check valves, pistons and rings.

No - Go to next step.

(14) Do valve tappets need adjustment? See “Valve Inspection and Repair” on page 215.

Yes - See “Valve Inspection and Repair” on page 215.

No - Go to next step.

(15) Are valves and/or valve seats burned or are valve seats loose? See “Valve Inspection and Repair” on page 215.

Yes - See “Valve Inspection and Repair” on page 215.

No - Go to next step.

(16) Has engine seized?

Yes - See “Engine Removal and Installation” on page 210.

No - Go to next step.

(17) Is camshaft worn?

Yes - See repair section.

CAUTION: Avoid Injury! Do not rotate engine with starting motor if the spark plugs are removed. Gasoline spray from the open cylinders may be ignited by ignition spark and cause an explosion or fire.

IMPORTANT: Avoid damage! Perform a visual inspection first to determine if battery cables are tight and not corroded and if the battery is of sufficient size to turn the engine over at minimum cranking speed of 350 rpm.

NOTE: To test specific electrical components, see Electrical Section and refer to either Diagnostics or Tests & Adjustments for further guidance.

Symptom: Engine Starts Hard.

(1) Are battery cables loose or dirty?

Yes - Tighten or clean.

No - Go to next step.

(2) Is battery fully charged? See “Battery Voltage and Specific Gravity Test” on page 330 in the Electrical section.

No - Charge battery. See “Battery - Charge” on page 331 in the Electrical section.

Yes - Go to next step.

(3) Is air cleaner dirty?

Yes - Clean or replace. See “Air Cleaner Removal and Installation” on page 203.

No - Go to next step.

(4) Is fuel pump defective?

Yes - Replace.

No - Go to next step.

(5) Is ignition coil air gap adjusted properly? See “Ignition Armature Air Gap Adjustment” on page 202.

No - Adjust as needed.

Yes - Go to next step.

(6) Is carburetor adjusted properly, clean? See “Carburetor Adjustment” on page 199.

No - Adjust or clean.

Yes - Go to next step.

(7) Are spark plugs loose/dirty?

Yes - Clean or replace and tighten to specifications.

No - Go to next step.

(8) Is fuel old or contaminated?

Yes - Replace

No - Go to next step.

(9) Does engine lack compression? See “Compression Test” on page 197.

Yes - Check valves, pistons and rings.

No - Go to next step.

(10) Do valve tappets need adjustment? See “Valve Inspection and Repair” on page 215.

Symptom: Engine Starts Hard.

Yes - Adjust as needed.

No - Go to next step.

(11) Are valves and/or valve seats burned or are valve seats loose? See "Valve Inspection and Repair" on page 215.

Yes - Repair or replace valves and/or seats as needed.

No - Go to next step.

(12) Is cylinder head warped? See "Cylinder Head Inspection and Repair" on page 215.

Yes - Replace. See "Cylinder Head Removal and Installation" on page 212 and "Cylinder Head Inspection and Repair" on page 215.

No - Go to next step.

(13) Is exhaust system restricted?

Yes - Clear exhaust system.

No - Go to next step.

(14) Is camshaft worn?

Yes - Replace.

No - Go to next step.

(15) Is connecting rod broken? See "Connecting Rod Inspection" on page 218.

Yes - See "Piston, Rings and Rod Removal and Installation" on page 217.

No - Go to next step.

(16) Are cylinder bore or rings worn? See "Cylinder Bore, Pistons and Rings:" on page 187.

Yes - See "Cylinder Bore, Pistons and Rings:" on page 187.

Symptom: Engine won't shut off

(1) Is magneto kill circuit grounded - shorted? See "Ignition Circuit Diagnosis - LX255, LX266, LX277 and LX288" on page 284 or "Ignition Circuit Diagnosis - LX279" on page 289 in the Electrical section.

Yes - Repair as needed.

No - Go to next step.

(2) Is carburetor adjusted properly, clean? See "Carburetor Adjustment" on page 199.

No - Adjust or clean carburetor.

Yes - Go to next step.

Symptom: Engine won't shut off

(3) Is fuel shutoff solenoid defective? See "Fuel Shutoff Solenoid Test" on page 197.

Yes - Replace.

Symptom: Loss of power

(1) Is air cleaner dirty?

Yes - Clean or replace. See "Air Cleaner Removal and Installation" on page 203.

No - Go to next step.

(2) Are fuel filter/lines clogged?

Yes - Replace or clean

No - Go to next step.

(3) Is fuel pump defective?

Yes - Replace.

No - Go to next step.

(4) Is ignition coil air gap adjusted properly? See "Ignition Armature Air Gap Adjustment" on page 202.

No - Adjust as needed.

Yes - Go to next step.

(5) Are spark plugs loose/dirty?

Yes - Clean or replace and tighten to specifications.

No - Go to next step.

(6) Is fuel old or contaminated?

Yes - Replace fuel.

No - Go to next step.

(7) Is fuel shutoff solenoid defective? See "Fuel Shutoff Solenoid Test" on page 197.

Yes - Replace.

No - Go to next step.

(8) Is carburetor adjusted properly, clean? See "Carburetor Adjustment" on page 199.

No - Adjust or clean as needed.

Yes - Go to next step.

(9) Do valve tappets need adjustment? See "Valve Inspection and Repair" on page 215.

Yes - Adjust as needed.

No - Go to next step.

Symptom: Loss of power

(10) Does engine lack compression? See "Compression Test" on page 197.

Yes - Check valves, pistons and rings.

No - Go to next step.

(11) Are valves and/or valve seats burned or are valve seats loose? See "Valve Inspection and Repair" on page 215.

Yes - Repair or replace valves and seats as needed.

No - Go to next step.

(12) Is cylinder head warped? See "Cylinder Head Inspection and Repair" on page 215.

Yes - Replace. See "Cylinder Head Removal and Installation" on page 212.

No - Go to next step.

(13) Is exhaust system restricted?

Yes - Clear exhaust system.

No - Go to next step.

(14) Is camshaft worn?

Yes - See repair section.

No - Go to next step.

(15) Is connecting rod broken? See "Connecting Rod Inspection" on page 218.

Yes - See "Piston, Rings and Rod Removal and Installation" on page 217.

No - Go to next step.

(16) Are cylinder bore or rings worn? See "Cylinder Bore Inspection" on page 220 and "Piston Inspection" on page 218.

Yes - See "Cylinder Bore, Pistons and Rings:" on page 187.

Engine Runs Erratically/Loss Of Power

IMPORTANT: Avoid damage! Before proceeding, inspect the mower deck and belts for binding in the spindle assemblies or belts that are too tight/loose. A loose belt like a loose blade can cause a backlash effect that will counteract engine cranking effort. Excessive drive belt tension may cause premature bearing wear or result in bearing seizure. Grass clippings that build up near the cutting blades can cause excessive resistance and heat buildup that causes problems with the engine's ability to turn the blades at a constant speed. Low lubricant levels in the spindles will buildup heat causing excessive resistance for the engine to deal with.

NOTE: To test specific electrical components, see Electrical Section and refer to either Diagnostics or Tests & Adjustments for further guidance.

There is a diode in-line in the magneto kill wire coming from each ignition module. This diode prevents feedback from one module to the other. Without these diodes, one magneto could fire the coil for the other magneto. If a diode fails in one of the magneto kill wires, that coil could be fired by the other module, the result may be similar to that of an erratic running engine.

A two cylinder engine may run adequately on one cylinder as long as the power required for the application does not exceed the power produced by the one cylinder.

Symptom: Low compression

(1) Are spark plugs loose/dirty?

Yes - Clean or replace and tighten to specifications.

No - Go to next step.

(2) Do valve tappets need adjustment? See "Valve Inspection and Repair" on page 215.

Yes - Adjust as needed.

No - Go to next step.

(3) Are cylinder head bolts loose? See "Cylinder Head Removal and Installation" on page 212.

Yes - Tighten to specification.

No - Go to next step.

(4) Is head gasket defective?

Yes - Replace. See "Cylinder Head Removal and Installation" on page 212.

No - Go to next step.

(5) Are valves and/or valve seats burned or are valve seats loose? See "Valve Inspection and Repair" on page 215.

Symptom: Low compression

Yes - Repair or replace as needed.

No - Go to next step.

(6) Is cylinder head warped? See "Cylinder Head Inspection and Repair" on page 215.

Yes - Replace. See "Cylinder Head Removal and Installation" on page 212 and "Cylinder Head Inspection and Repair" on page 215.

No - Go to next step.

(7) Is camshaft worn?

Yes - See repair section.

No - Go to next step.

(8) Is connecting rod broken? See "Connecting Rod Inspection" on page 218.

Yes - See "Piston, Rings and Rod Removal and Installation" on page 217.

No - Go to next step.

(9) Are cylinder bore or rings worn? See "Cylinder Bore, Pistons and Rings:" on page 187.

Yes - See "Cylinder Bore, Pistons and Rings:" on page 187.

Symptom: Excessive engine noise/vibration

(1) Is there grass buildup under deck?

Yes - Clean deck.

No - Go to next step.

(2) Is mower deck binding or dragging?

Yes - See "Mower Decks Troubleshooting Chart" on page 537 in the Attachments section.

No - Go to next step.

(3) Is there sufficient lubrication in gear box or hydro/transaxle?

No - Fill to specification.

Yes - Go to next step.

(4) Are the mounting bolts loose?

Yes - Tighten bolts.

No - Go to next step.

(5) Is cutter blade or other rotating part bent or out of balance?

Yes - See Balance Blades for your appropriate mower deck in the Attachments section.

Symptom: Excessive engine noise/vibration

No - Go to next step.

(6) Have the deck spindles seized?

Yes - See "38-Inch Deck Spindles" on page 565, "42-Inch Deck Spindles" on page 566, "44-Inch Deck Spindles" on page 571, "48-Inch Deck Spindles" on page 573, or "54-Inch Deck Spindles" on page 576 in the Attachments section.

No - Go to next step.

(7) Is connecting rod broken? See "Connecting Rod Inspection" on page 218.

Yes - See "Piston, Rings and Rod Removal and Installation" on page 217.

No - Go to next step.

(8) Are cylinder bore or rings worn? See "Cylinder Bore Inspection" on page 220.

Yes - See "Cylinder Head Inspection and Repair" on page 215.

Symptom: Low oil pressure

(1) Is the oil level low or is the oil the wrong viscosity?

Yes - See "4 - Cycle Gasoline Engine Oil" on page 15 in the Specifications section.

No - Go to next step.

(2) Are the oil galleries or filter clogged?

Yes - Clean or replace filter.

No - Go to next step.

(3) Is the oil pump defective? See "Engine Oil Pressure Test" on page 201.

Yes - Repair or replace as needed. See "Oil Pump Removal" on page 228.

No - Go to next step.

(4) Are the internal bearings worn or is there excessive tolerance?

Yes - See "PTO and Cam Bearing Inspection" on page 227.

No - Go to next step.

Symptom: Engine is running on one cylinder

(1) Is ignition coil air gap adjusted properly? See "Ignition Armature Air Gap Adjustment" on page 202.

Symptom: Engine is running on one cylinder

No - Adjust air gap to specification.

Yes - Go to next step.

(2) Are spark plugs loose/dirty?

Yes - Clean or replace and tighten to specifications.

No - Go to next step.

(3) Is magneto kill circuit grounded - shorted? See "Ignition Circuit Diagnosis - LX255, LX266, LX277 and LX288" on page 284 or "Ignition Circuit Diagnosis - LX279" on page 289 in the Electrical section.

Yes - Repair as needed.

No - Go to next step.

(4) Do valve tappets need adjustment? See "Valve Inspection and Repair" on page 215.

Yes - See "Valve Inspection and Repair" on page 215.

No - Go to next step.

(5) Does engine lack compression? See "Compression Test" on page 197.

Yes - Check valves, pistons and rings.

No - Go to next step.

(6) Are cylinder head bolts loose? See "Cylinder Head Removal and Installation" on page 212.

Yes - Tighten to specification.

No - Go to next step.

(7) Is head gasket defective?

Yes - Replace. See "Cylinder Head Removal and Installation" on page 212.

No - Go to next step.

(8) Are valves and/or valve seats burned or are valve seats loose? See "Valve Inspection and Repair" on page 215.

Yes - Repair or replace as needed.

No - Go to next step.

(9) Is cylinder head warped? See "Cylinder Head Inspection and Repair" on page 215.

Yes - Replace. See "Cylinder Head Removal and Installation" on page 212.

No - Go to next step.

Yes - See repair section.

Symptom: Engine is running on one cylinder

No - Go to next step.

(10) Is connecting rod broken? See "Connecting Rod Inspection" on page 218.

Yes - See "Piston, Rings and Rod Removal and Installation" on page 217.

No - Go to next step.

(11) Are cylinder bore or rings worn? See "Piston Inspection" on page 218 and "Cylinder Bore Inspection" on page 220.

Yes - Repair or replace as needed.

Symptom: Engine overheats

(1) Is there grass buildup under deck?

Yes - Clean deck.

No - Go to next step.

(2) Are cylinder cooling fins or blower housing filled with grass clippings?

Yes - Clean.

No - Go to next step.

(3) Is mower deck binding or dragging?

Yes - See "Mower Decks Troubleshooting Chart" on page 537 in the Miscellaneous section.

No - Go to next step.

(4) Is there sufficient lubrication in gear box or hydro/transaxle?

No - Fill to specification.

Yes - Go to next step.

(5) Is there excessive drive belt tension?

Yes - See "Traction Drive Belt Removal and Installation" on page 439 and "Traction Drive Belt Tensioner Assembly" on page 442 in the Power Train section.

No - Go to next step.

(6) Have the deck spindles seized?

Yes - See "38-Inch Deck Spindles" on page 565, "42-Inch Deck Spindles" on page 566, "44-Inch Deck Spindles" on page 571, "48-Inch Deck Spindles" on page 573, or "54-Inch Deck Spindles" on page 576 in the Attachments section.

No - Go to next step.

(7) Is the oil level low or is the oil the wrong viscosity?

Symptom: Engine overheats

Yes - See "4 - Cycle Gasoline Engine Oil" on page 15 in the Specifications section.

No - Go to next step.

(8) Is the exhaust system restricted?

Yes - Clear exhaust system.

No - Go to next step

(9) Is air/fuel mixture excessively lean?

Yes - See "Carburetor Adjustment" on page 199.

Symptom: Fuel mixture too rich

(1) Is air cleaner dirty?

Yes - Clean or replace. See "Air Cleaner Removal and Installation" on page 203.

No - Go to next step.

(2) Are cylinder bore or rings worn? See "Piston Inspection" on page 218 and "Cylinder Bore Inspection" on page 220.

Yes - Repair or replace as needed.

No - Go to next step.

(3) Is connecting rod broken? See "Connecting Rod Inspection" on page 218.

Yes - Replace as needed.

No - Go to next step.

(4) Is camshaft worn?

Yes - See repair section.

Tests and Adjustments

Throttle Cable Adjustment

Reason:

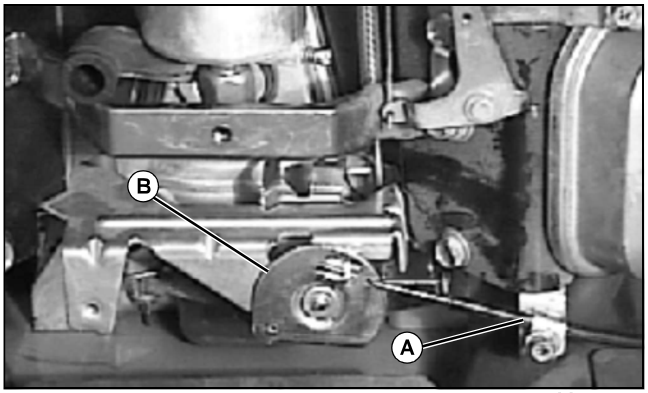
To make sure the throttle cable moves the throttle through its full range of movement.

Procedure:

1. Remove air cleaner assembly, and base. See "Air Cleaner Removal and Installation" on page 203.

NOTE: Nuts securing air cleaner base to carburetor also secure carburetor to intake manifold. DO NOT run engine with nuts removed.

2. Install nuts on carburetor studs.
3. Move throttle lever to FAST idle position.



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4. Loosen throttle cable clamp (A).
5. Move throttle cable until governor control swivel (B) is at end of travel.
6. Tighten throttle cable clamp.

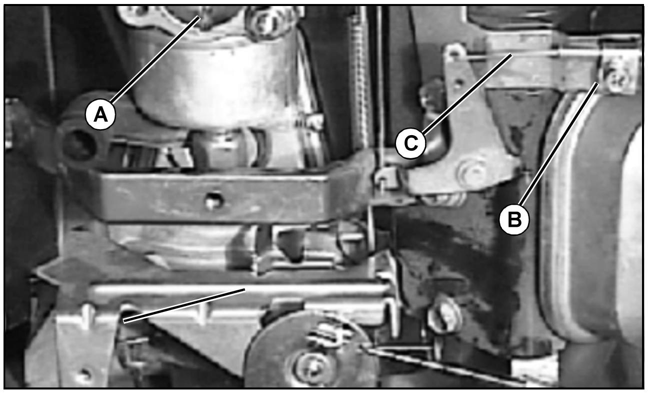
Choke Cable Adjustment

Reason:

To make sure the choke cable moves the choke through its full range of movement.

Procedure:

1. Park machine on a level surface. STOP engine. Remove key. Set parking brake.
2. Remove air cleaner assembly from carburetor.
3. Check choke lever to make sure it is completely OFF (rear most position).



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4. Check choke butterfly (A) to make sure it is completely open.

5. If choke butterfly is not completely open:

- Loosen choke cable clamp (B).
- Move choke cable (C) until butterfly is completely open.
- Tighten choke cable clamp.

6. Push choke lever forward and make sure choke is completely closed at full choke. Readjust if necessary.

Fuel Shutoff Solenoid Test

Reason:

To test proper operation of fuel shutoff solenoid.

Required Tools:

- Jumper wire

Procedure:

1. Listen for an audible click when ignition switch is turned from OFF to ON.
2. If solenoid does not click, problem could be in equipment wiring.
3. Disconnect wire from solenoid.
4. Momentarily place a jumper wire from solenoid wire to battery positive terminal.
5. If solenoid now clicks, the solenoid is working properly.

Results:

- Solenoid is operating properly if a click is heard when ignition switched from OFF to ON.

Compression Test

Reason:

To determine the performance difference between cylinders.

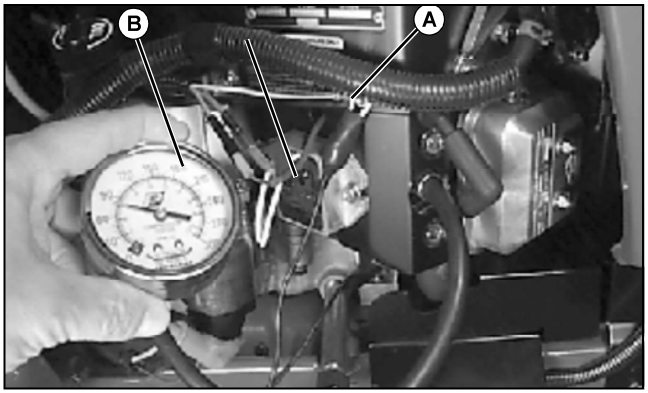
Required Tools:

NOTE: Briggs & Stratton does not publish compression pressures, as it is difficult to obtain an accurate reading without special equipment. Briggs & Stratton recommends calculating the difference in compression readings between the two cylinders. Two methods follow; with or without a cylinder leak tester.

- JDM59 Compression Gauge

Without Cylinder Leak Tester

IMPORTANT: Avoid damage! The battery must be fully charged for this test.
Check and adjust the valves to ensure the valves have not been adjusted too tight. If either valve is off its seat the leak test will be invalid.



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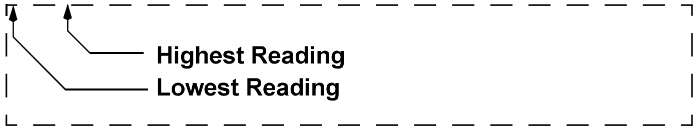
1. Remove spark plugs. Ground the magnetos by attaching a jumper wire (A) from the magneto kill circuit connector to the engine to prevent a spark that could ignite anything combustible.
2. Insert a compression gauge (B) into either cylinder.
3. Turn engine over with the starting motor until the highest pressure reading is obtained and record reading.
4. Repeat steps 2 and 3 with the next cylinder and record reading.
5. Use the following example and insert the recorded readings to determine the percent of leakage between cylinders.

Example:

Cyl #1	Cyl #2
75 psi	55 psi

Formula:

55 ± 75 = 0.7333 x 100 = 73.333, 100 - 73.333 = 26.7%



Results:

- A difference of more than 25% indicates a loss of compression in the cylinder with the lowest reading.

With Cylinder Leak Tester

Required Tools:

- JT03502 Cylinder Leak Tester
- Breaker Bar & 30 mm Socket

NOTE: If the directions that come with the tester being used are different than the following, use the directions that came with the tester.

IMPORTANT: Avoid damage! Check and adjust the valves to ensure the valves have not been adjusted too tight. If either valve is off its seat the leak test will be invalid.

1. The engine should be run for at least five minutes to bring the engine to operating temperature

CAUTION: Avoid injury! With spark plugs removed, the magnetos must be grounded to the engine to prevent a spark that could ignite anything combustible.

2. Remove spark plugs. Ground the magnetos by attaching a jumper wire from the magneto kill circuit connector to the engine to prevent a spark that could ignite anything combustible.

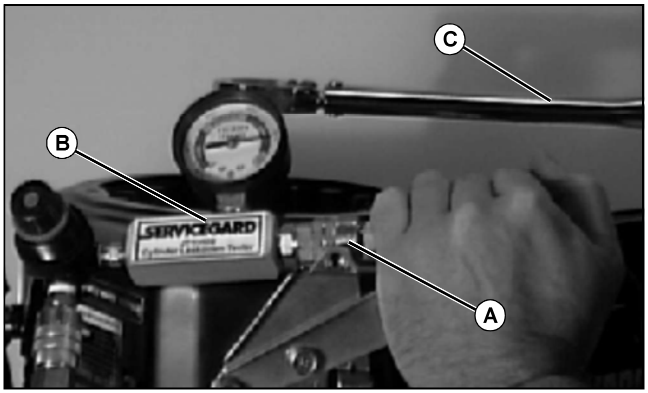
IMPORTANT: Avoid damage! The piston must be positioned at Top Dead Center (TDC) to ensure that the intake valves are away from the compression relief balls. If not, the intake valve will be open and the leak test will be invalid.

3. Remove valve covers.
4. Remove the rotating screen.
5. Turn crankshaft until piston is at TDC, on the compression stroke (both valves closed)
6. Screw the adaptor into the spark plug hole but do not attach it to the tester at this time.
7. Pull back the locking ring and rotate the regulator knob fully counterclockwise. Connect an air line to the tester.

IMPORTANT: Avoid damage! The air supply must have supply pressure of 586 - 655 kPa (85 - 95 psi) to calibrate the tester.

8. Pull back the locking ring and rotate the regulator knob clockwise until the gauge needle rests in the SET range of the gauge. Push the locking ring toward the tester to lock it.

NOTE: A small amount of air escaping from the crankcase breather is normal.



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9. Connect the adaptor hose (A) to the tester (B) and record the needle position while holding the flywheel in position with a socket and long drive handle (C).

Results:

- Excessive air escaping from the crankcase breather indicates worn piston rings or cylinder wall
- Air escaping from the carburetor indicates a worn intake valve or seat
- Air escaping from the exhaust pipe indicates a worn exhaust valve or seat
- Gauge reading in the GREEN (low) area indicates good compression (less than 25% is considered normal)
- Gauge reading in the YELLOW (moderate) area indicates borderline compression. The engine is still usable but an overhaul or replacement should be considered
- Gauge reading in the RED (high) area indicates excessive compression loss and engine reconditioning or replacement is necessary

Carburetor Adjustment

Reason:

To set the carburetor screw for proper operation of the carburetor.

IMPORTANT: Avoid damage! DO NOT attempt to disassemble or adjust the carburetor unless you are a factory trained technician with authorization to service CARB/EPA Certified Emissions Carburetors.

Equipment:

- JT07270 Pulse Tachometer

IMPORTANT: Avoid damage! To obtain correct operation of the carburetor, the adjustment procedure MUST be performed in the sequence shown.

Initial Adjustment

Procedure:

1. Remove hood, air cleaner assembly, and base. See “Air Cleaner Removal and Installation” on page 203.

NOTE: Nuts securing air cleaner base to carburetor also secure carburetor to intake manifold. DO NOT run engine with nuts removed.

2. Install nuts on carburetor studs.

3. Remove limiter cap.

4. Turn idle mixture screw clockwise until it just seats. DO NOT FORCE.

5. Turn screw 1¼ turns counter-clockwise. This setting will allow the engine to start.

Final Adjustment

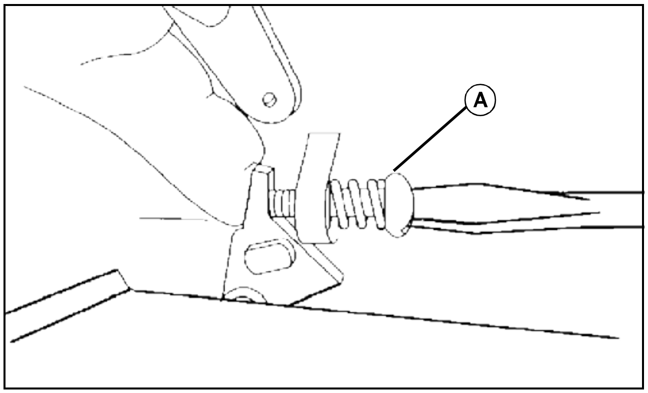
NOTE: All carburetor adjustments with engine running must be made with the air cleaner installed.

1. Install air cleaner base and air cleaner.

2. Start and run engine for five minutes to allow engine to reach operating temperature.

3. Move throttle lever to SLOW position.

4. Install pulse tachometer.



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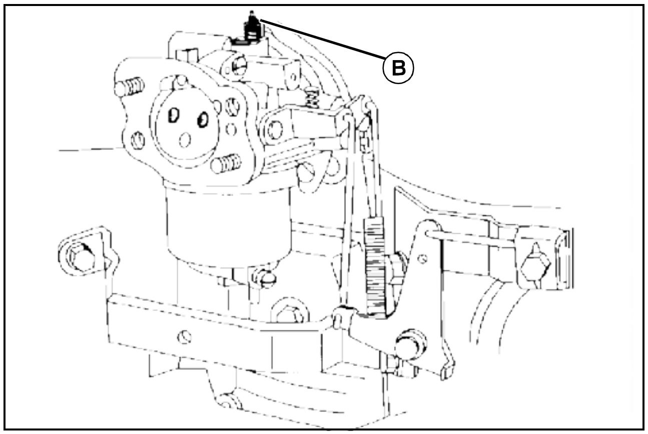
5. Hold throttle lever against idle speed screw (A) and temporarily adjust idle speed to 1400 rpm.



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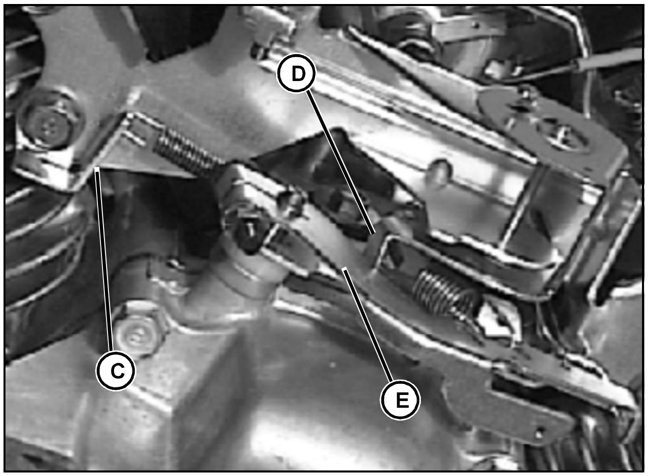
6. Turn idle mixture screw (B) slowly clockwise until engine speed just starts to slow (lean mixture).

7. Turn screw to the midpoint between rich and lean mixture settings.

8. Hold throttle lever against idle speed adjustment screw and readjust idle speed to 1200 rpm.

9. Release throttle lever and note rpm.



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10.If necessary bend idle tang (C) to obtain 1750 rpm.

11.Position limiter cap so that stops on limiter cap are at midpoint between stops on carburetor.

12.With throttle lever in the SLOW position and engine running at governed idle rpm, bend throttle restrictor tang (D) so that it just contacts governor lever (E).

13.Move throttle lever to FAST position.

14.Engine should accelerate smoothly. If necessary, readjust idle mixture screw 1/8 turn counter-clockwise (richer mixture).

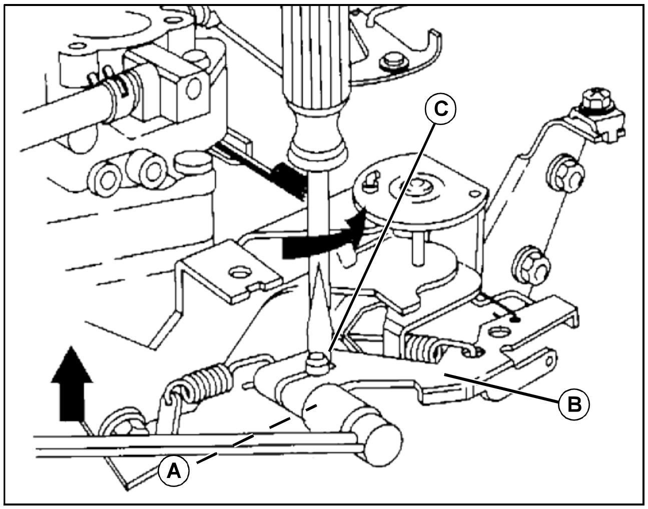
Governor Adjustment

CAUTION: Avoid injury! Before starting or running engine, static adjustment of the governor must be made. Failure to make static adjustments first, could result in engine over-speeding, and may result in engine or equipment damage causing personal injury and/or property damage.

Static Adjustment (Engine OFF)

NOTE: All linkage must be installed to make adjustment.

Procedure:



M89124

1. Remove:
   - Hood
   - Top muffler shield
   - Air cleaner assembly
2. Loosen governor lever bolt (A) and nut.
3. Push on governor lever (B) until throttle is wide open.

IMPORTANT: Avoid damage! Do not bend governor link or distort governor lever.

4. Hold lever in this position and rotate governor shaft (C) counterclockwise as far as it will go. Hold lever and shaft in position and tighten governor lever bolt and nut to 8 N•m (70 lb-in.).

Dynamic Adjustment (Engine Running)

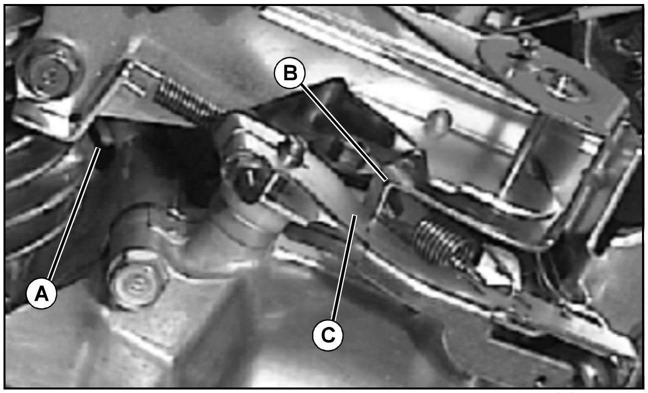
NOTE: Carburetor mixture adjustments must be made before adjusting governed idle, throttle restrictor and top no load rpm adjustments.

Special or Required Tools:

- Pulse Tachometer JT07270

Procedure:

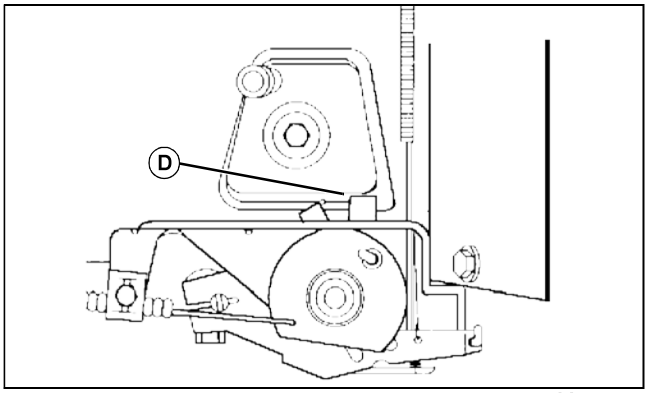
1. Move throttle lever to SLOW idle position.



M92396

2. Bend governor idle tang (A) to obtain specified slow idle of 1750 ± 100 rpm.

3. With throttle lever in SLOW position and engine running at governed idle, bend throttle restrictor tang (B) so that it just contacts the governor lever (C).



M92397

4. Move throttle lever to FAST idle position and bend fast idle tang (D) to obtain specified top no load engine speed.

Specifications:

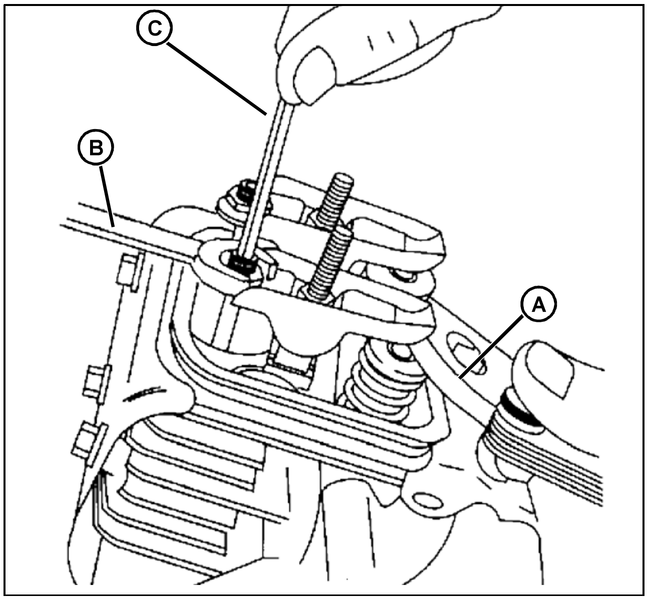
Slow Idle . . . . 1550 ± 100 rpm

Fast Idle. . . . . 3350 ± 50 rpm

Valve Clearance Adjustment

NOTE: Correct position of crankshaft is necessary to eliminate interference by the compression release mechanism on the cam gear when adjusting valve clearance.

1. Remove valve cover.
2. Turn crankshaft until piston is at TDC of the compression stroke (both valves closed).
3. Insert a screwdriver through the spark plug opening until it touches the top of the piston.
4. Continue to turn the crankshaft clockwise until the piston has moved down 6.35 mm (0.25 in.).



M87841

5. Check valve clearance with a feeler gauge (A) between valve stem and rocker arm. Valve clearance should be 0.10 - 0.16 mm (0.004 - 0.006 in.).
6. If not, adjust as necessary using a 13 mm open end wrench (B) and a 5 mm hex wrench (C). Tighten locknut to 7 N•m (60 lb-in.).
7. Recheck valve clearance. Make adjustments as required.
8. Install valve cover.

Specifications:

Locknut . . . . 7 N•m (65 lb-in.)

Valve Clearance . . . . . 0.10 - 0.16 mm (0.004 - 0.006 in.)

Engine Oil Pressure Test

Reason:

To verify that the engine has sufficient oil pressure to lubricate internal engine components.

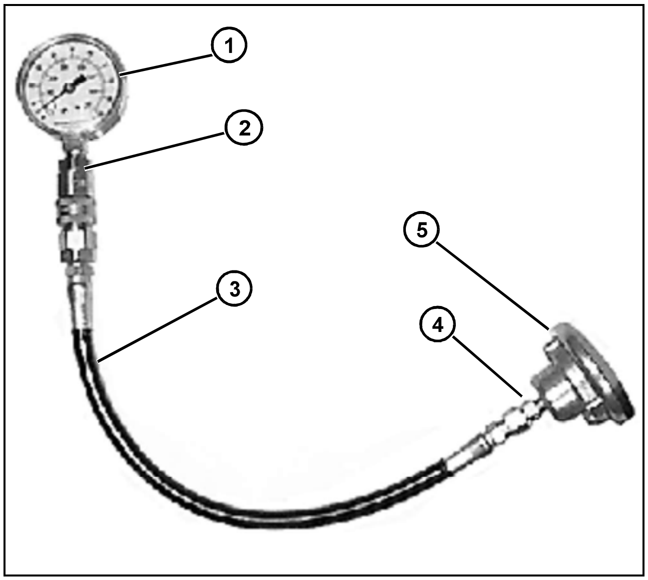
Equipment:

- JT07262 Oil Pressure Test Adapter w/O-ring (required ONLY on engines without test ports)
- JT05487 Connector
- JT03017 Hose Assembly
- JT03262 Coupler
- JT07034 Gauge, 0 - 700 kPa (0 - 100 psi)

NOTE: The connector, hose assembly, coupler, and gauge are found in other SERVICEGARD™ test kits.

Test Procedure:

1. Perform test procedure with engine level.
2. Stop engine.
3. Disconnect spark plug wires. Allow engine to cool.
4. Remove oil pressure switch from the oil filter adapter.
5. Screw connector end (4) of gauge assembly into oil pressure switch opening.
6. Check crankcase oil level and adjust to full mark.



M91215a

1. JT07034 Gauge
2. JT03262 Coupler
3. JT03017 Hose Assembly
4. JT05487 Connector
5. JT07262 Oil Pressure Adapter, w/ O-Ring

7. Monitor the oil pressure during cranking. If the pressure is below 28 kPa (4 psi) - STOP cranking the engine immediately and correct the cause before continuing.
8. Connect spark plug wires.
9. Warm-up engine by running for five minutes.

CAUTION: Avoid injury! Engine components are HOT. DO NOT touch with bare skin. Wear protective eye glasses and clothing.

10. Record oil pressure reading at FAST idle.
11. Stop engine and allow to cool.

Results:

If oil pressure reading is not within 103 - 345 kPa (15 - 50 psi) at FAST idle, inspect and/or replace the following:

a. Oil pump assembly. See “Oil Pump Removal” on page 228.

b. Oil suction screen

c. Oil passages

d. Bearing wear

e. Oil Seals

12. Remove adapter, connector, hose assembly, coupler, and gauge.
13. Reinstall oil pressure switch.
14. Run engine for 30 seconds and stop engine.
15. Check crankcase oil level and adjust to FULL mark.

Ignition Armature Air Gap Adjustment

Reason:

To set proper ignition coil air gap.

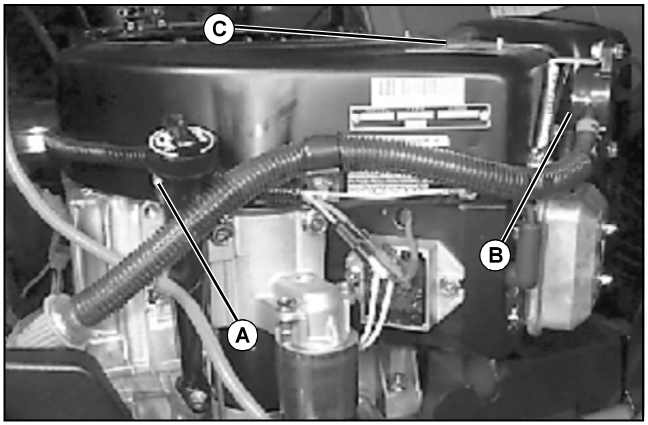
Procedure:

1. Rotate the flywheel until the flywheel magnet is underneath the armature.
2. Place a 0.20 - 0.30 mm (0.008 - 0.012 in.) thickness gauge (A) between the flywheel magnet and the armature.
3. Loosen the mounting screws, allowing the magnet to pull the armature against the thickness gauge.
4. Tighten the mounting screws to 2.8 N•m (25 lb-in.).
5. Rotate the flywheel to remove the thickness gauge.
6. Repeat for remaining cylinder.

Repair

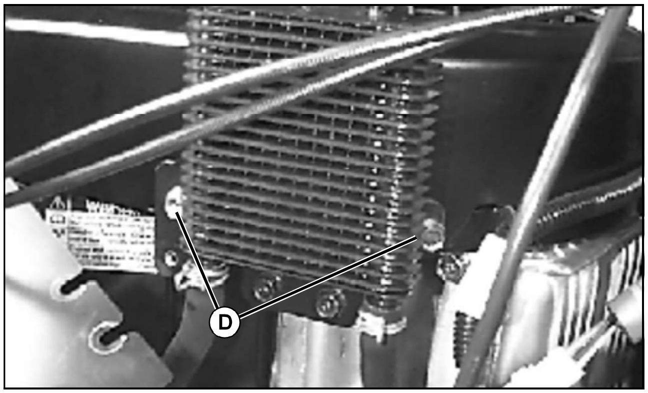
Upper Blower Housing Removal and Installation

Procedure:



M95088

1. Remove rotating screen.
2. Disconnect upper bolt (A) on dipstick tube.
3. Remove fuel pump (B) and bracket.
4. Remove top carburetor access plate (C).

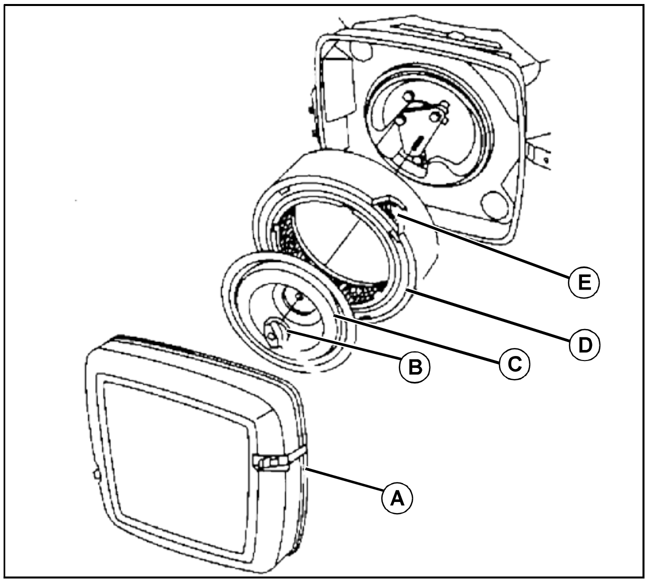


M95089

NOTE: Steps 5 and 6 are only required on engines with oil coolers.

5. Remove bottom cap screw securing oil cooler cover, and loosen the top two cap screws (D). Move cover out of the way.
6. Remove two cap screws securing oil cooler to the blower housing.
7. Remove upper blower housing.
8. Install in reverse order of removal.

Air Cleaner Removal and Installation

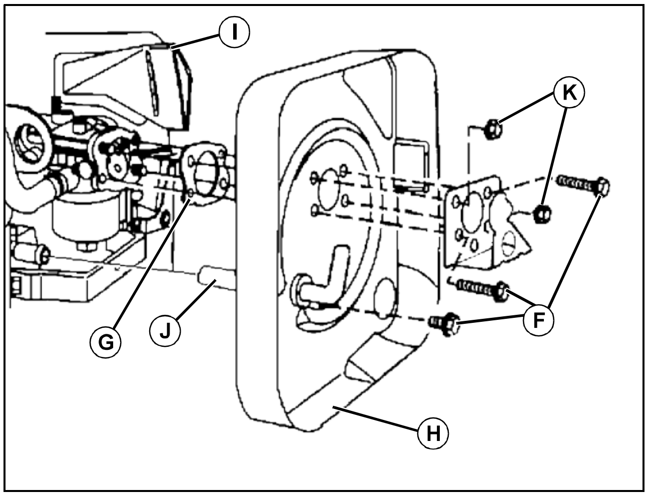


M87006

IMPORTANT: Avoid damage! DO NOT use petroleum solvents, such as kerosene, to clean foam pre-cleaner. They may cause foam to deteriorate. DO NOT oil paper cartridge. DO NOT use pressurized air to clean or dry paper cartridge. If paper cartridge is dirty replace with new cartridge.

1. Remove the hood.
2. Remove cover (A), knob (B) and plate (C).
3. Slide foam pre-cleaner (D) off cartridge (E).
    - Wash pre-cleaner in liquid detergent and water.
    - Squeeze dry in a clean cloth.
    - Saturate in clean engine oil. Wrap in a clean absorbent cloth and squeeze to remove excess oil.
4. Remove cartridge and clean by tapping gently on a flat surface. Replace cartridge if dirty.

NOTE: Nuts (K) securing air cleaner base to carburetor also secure carburetor to intake manifold. DO NOT run engine with nuts removed.



M88900a

5. Remove screws (F), gasket (G), air cleaner housing (H), air inlet tube (I) and breather tube (J).

Installation:

IMPORTANT: Avoid damage! Be sure breather tube is not kinked and that it is installed onto nipple as far as possible.

Installation is the reverse of removal.

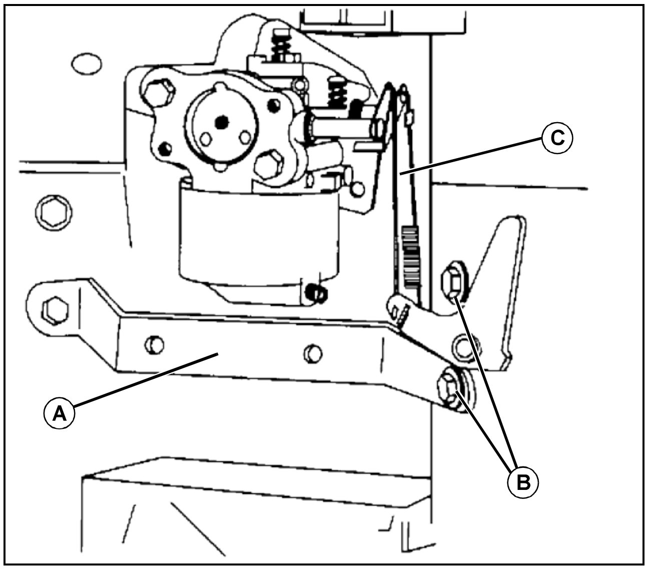
Carburetor Removal and Installation

Removal:

1. Remove air cleaner. See “Air Cleaner Removal and Installation” on page 203.
2. Remove upper blower housing.

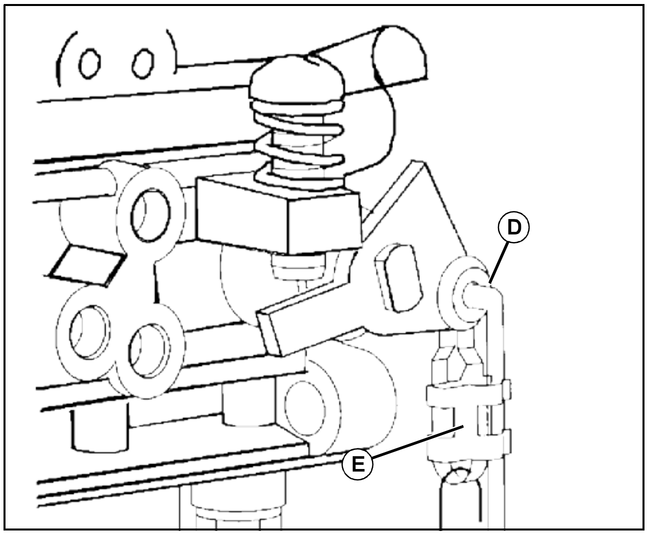
NOTE: The engine is equipped with fuel shutoff solenoid. The blower housing should be removed so that the solenoid wire can be properly routed during reassembly. Disconnect fuel shutoff solenoid wire from equipment switch wire.

3. Remove air cleaner base and breather tube.



M88870

4. Remove air cleaner bracket (A).
5. Remove two screws (B) and choke control bracket.
6. Disconnect choke link (C) from carburetor.
7. Remove fuel line clamp and fuel line from carburetor.



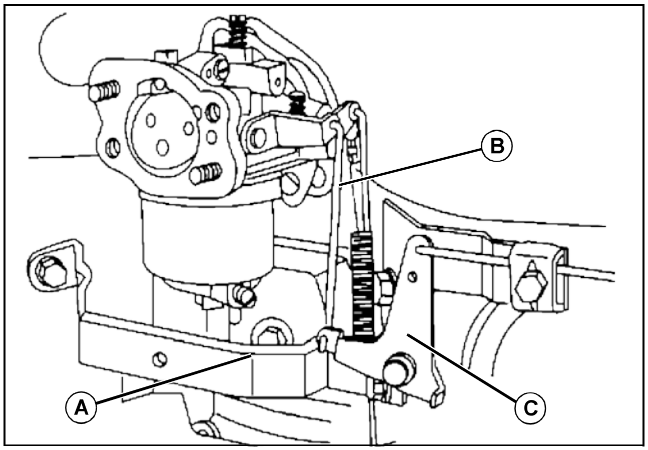
M88901

8. Disconnect governor link (D), retainer (E) and spring.
9. Remove carburetor, gaskets and spacer.

Installation:

1. Install spacer, gaskets and carburetor. Tighten to 7 N•m (65 lb-in.).

2. Connect governor link to throttle lever and snap retainer over link. Then install governor link spring in loop on retainer.



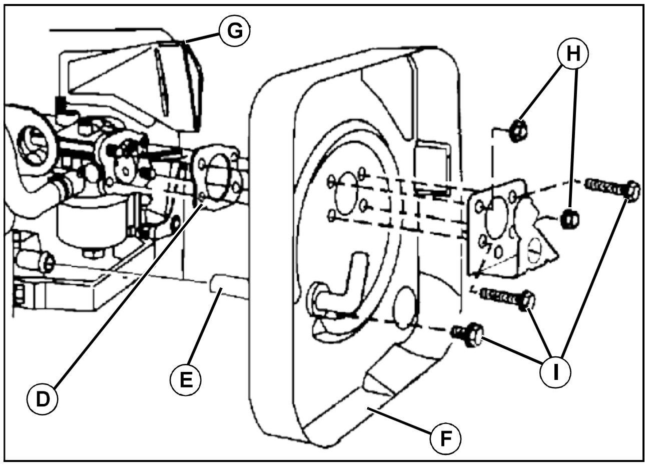
M88899

3. Install air cleaner bracket (A) and tighten two screws to 7 N•m (65 lb-in.).

4. Install choke link (B) on choke lever on carburetor. Connect link to choke control lever and install choke control bracket (C).

5. Install fuel line and fuel line clamp.

6. Install blower housing.



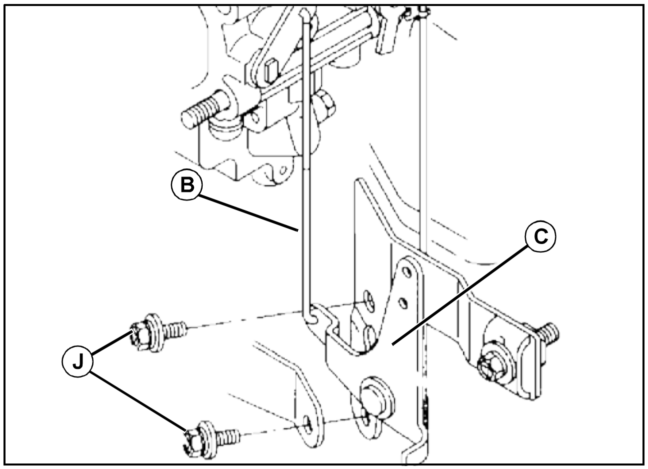
M88900a

7. Install gasket (D), breather tube (E), air cleaner base (F), air inlet tube (G), nuts (H), and screws (I).

CAUTION: Avoid injury! Static governor adjustment must be made whenever carburetor or manifold has been removed from engine. Failure to make static adjustments first could result in engine over-speeding and may result in engine or equipment damage causing personal injury or property damage

IMPORTANT: Avoid damage! Be sure breather tube is not kinked and that it is installed onto nipple as far as possible.

8. Install air cleaner cartridge, pre-cleaner and cover.



M88902

9. Connect choke link (B) to choke lever. Install choke control bracket (C). Tighten screws (J) to 7 N•m (65 lb-in.).

10.Install blower housing and rotating screen. Install fuel pump and bracket and connect fuel line to carburetor.

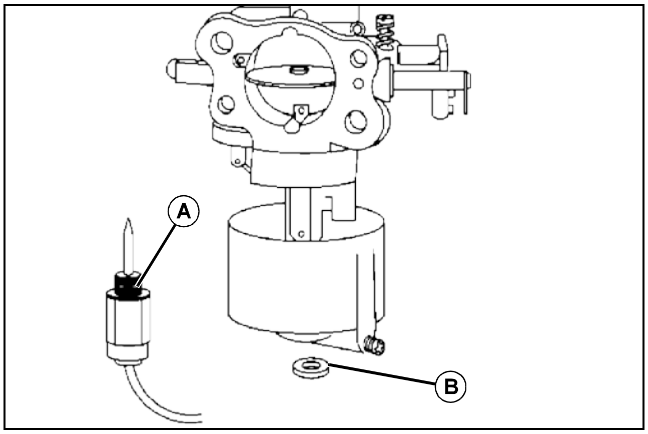
NOTE: Make sure air inlet tube is installed correctly in air cleaner base.

11.Rotate fuel line clamp so that it will not interfere with carburetor cover. DO NOT install carburetor cover at this time.

Carburetor Disassembly

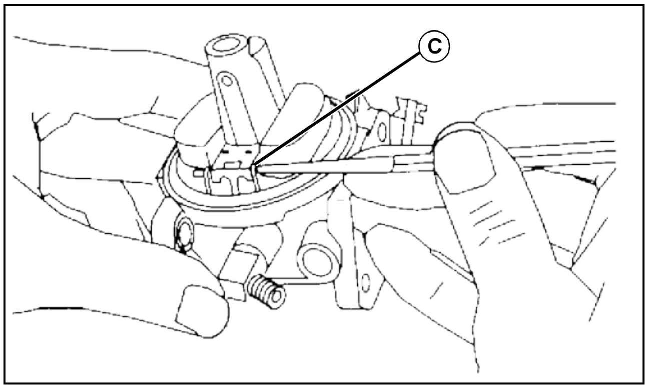
Procedure:

1. Observe position of bowl drain screw to aid in reassembly.



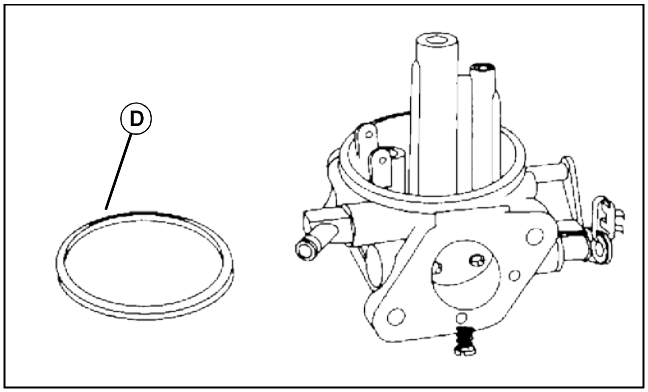
M94887

2. Remove fuel shutoff solenoid (A) and washer (B) and bowl.



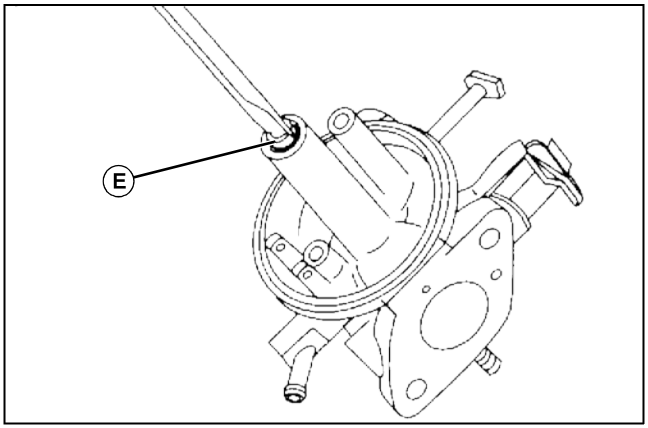
M88873

3. With a small punch, drive the float hinge pin (C) out of float hinge. Remove float and fuel inlet valve assembly.



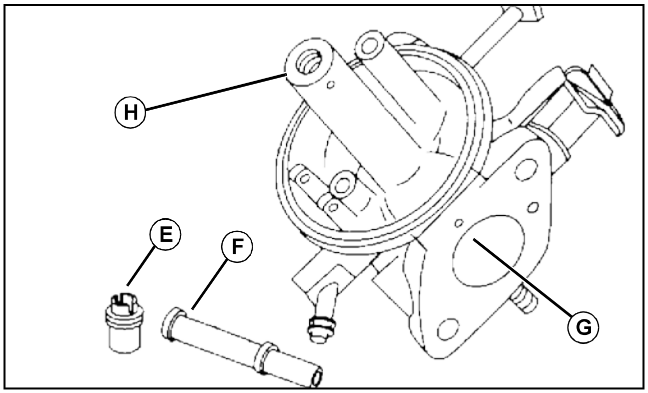
M88874

4. Remove carburetor bowl gasket (D).



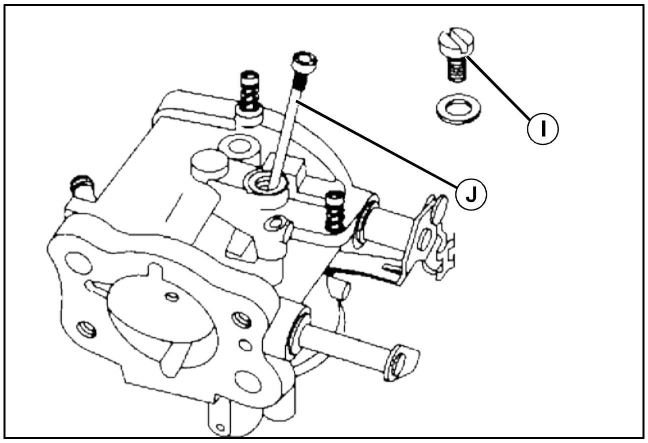
M88875

5. Remove fixed main jet (E) using a small blade screwdriver.



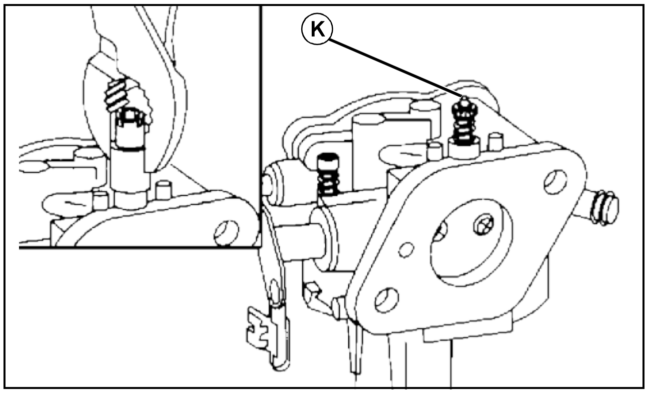
M88876

6. With the fixed main jet removed, the high speed nozzle (F) can be removed. Reach into carburetor throat (G) with a flat blade screw driver and push the high speed nozzle up through fixed main jet tube (H).



M88877

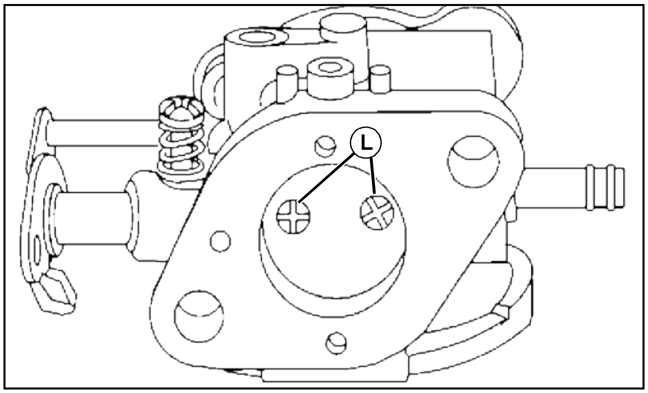
7. Remove idle jet plug (I) and idle jet (J).



M88878

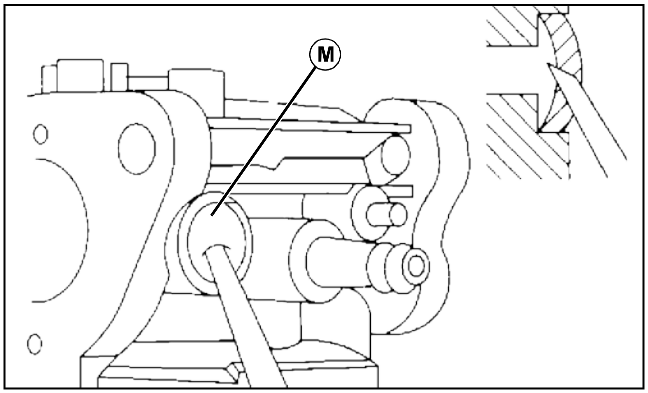
8. The idle mixture valve (K) is equipped with a adjustment limiter cap. Use pliers to remove the cap.

9. Remove the idle mixture valve.



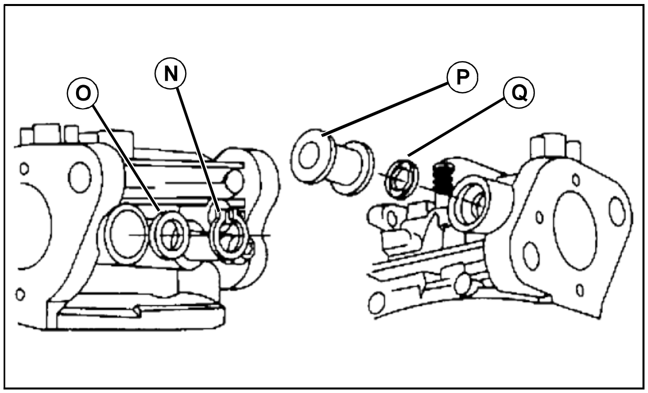
M88879

10.Remove two screws (L) holding throttle valve to throttle shaft and remove throttle valve



M88880

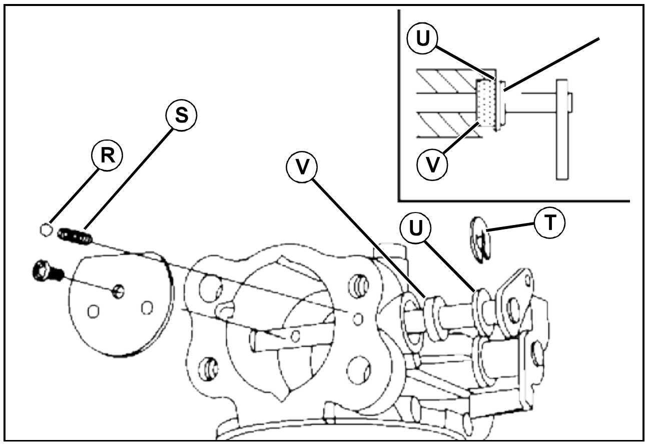
11.To remove throttle shaft it is necessary to first remove welch plug (M) from side of carburetor. Use a punch to pry plug out.



M88881

12.Remove external snap ring (N) and throttle shaft washer (O).

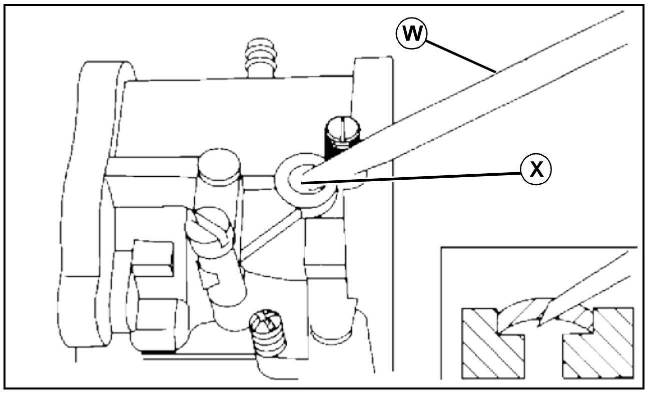
13.Remove throttle shaft, throttle shaft collar (P) and throttle shaft seal (Q) (lip out).



M88882

NOTE: The choke shaft has a ball (R) and spring (S) that keeps tension on the choke shaft. Use care when removing choke shaft.

14.Remove choke valve screw and choke valve. Remove E- ring (T), then remove choke shaft, washer (U) and felt seal (V).



M88883

15.Using a punch (W), remove small welch plug (X) from top of carburetor body.

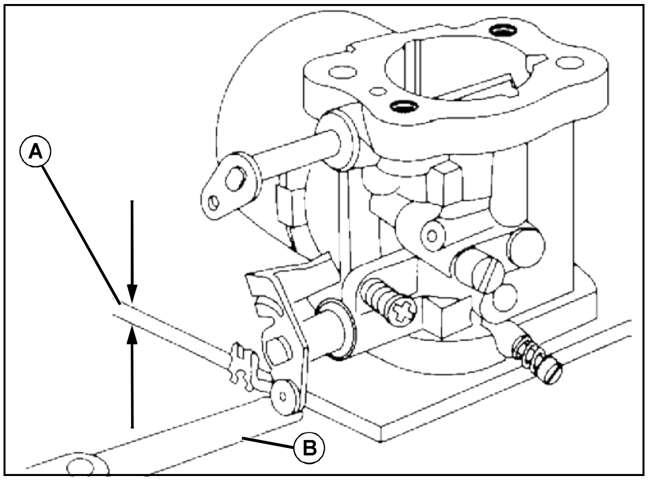
Carburetor Inspection

IMPORTANT: Avoid damage! A clean fuel system is necessary in order to maintain proper operation of the engine. Gummy or dirty fuel tanks and carburetors should be cleaned with a commercial carburetor cleaner. DO NOT soak rubber, neoprene or plastic parts in cleaner.

1. Check all moving parts for wear, nicks and burrs. Replace, if worn or damaged.

2. Check float for leaks or damage. Replace, if damaged or leaking.

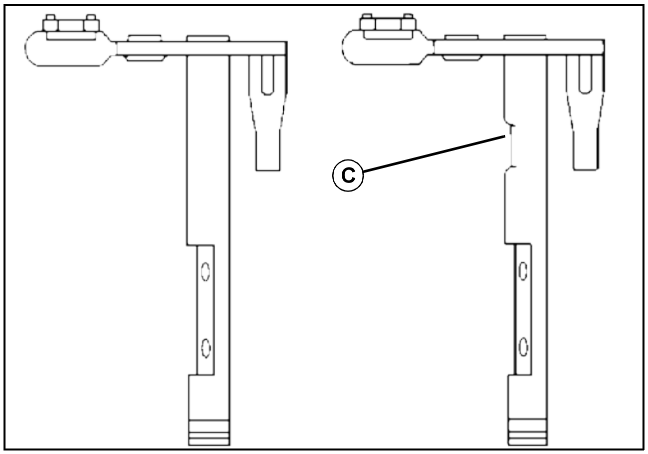
3. Check all mating surfaces for nicks, burrs, foreign material, or cracks. Replace all damaged parts.



M88884

4. Inspect throttle and choke shaft and bushings for wear. Wear between throttle shaft and bushing should not exceed 0.25 mm (0.010 in.).

5. Check wear by placing carburetor on a flat surface 3 mm (1/8 in.) thick (A). Measure the distance between the throttle lever and flat surface with a feeler gauge (B) while moving shaft up and down. A difference greater than 0.25 mm (0.010 in.) indicates the throttle shaft and/or bushings are worn.



M88885

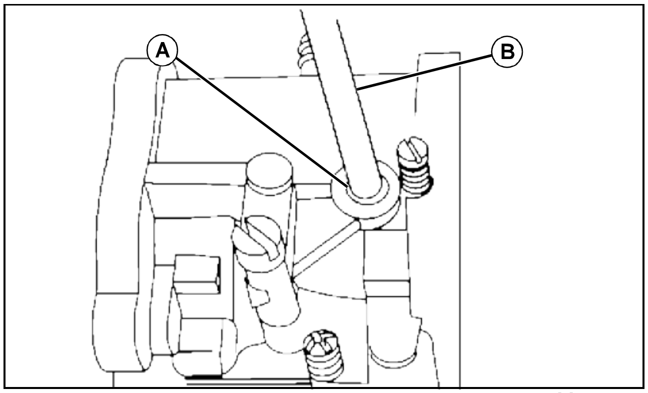
6. Wear on the throttle shaft (C) can be checked by comparing the worn and unworn portions of the shaft.

7. Choke shaft and bushings are checked in the same manner.

8. Throttle and choke shaft are replaceable. If throttle or choke shaft bushings are worn, replace carburetor.

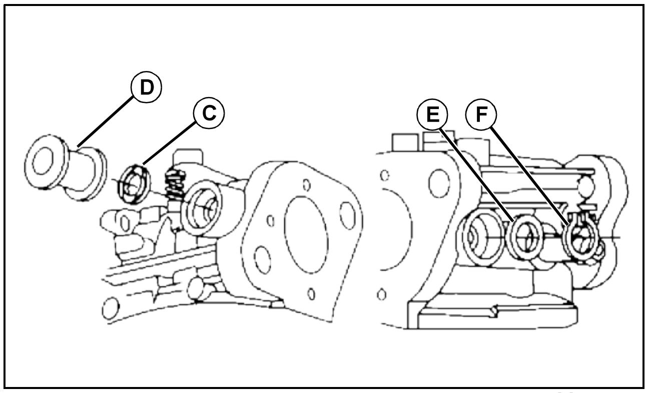
Carburetor Assembly

IMPORTANT: Avoid damage! When assembling the carburetor, use new seals and gaskets.



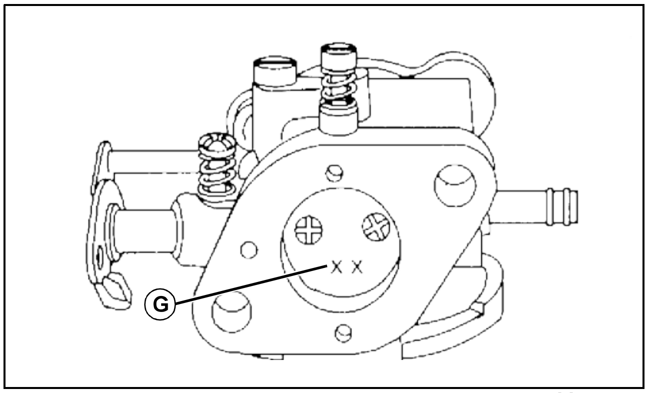
M88886

1. Install new secondary idle port welch plug (A). Use a round punch (B) and tap in plug until it is flat. Use a sealant such as Permatex® #2 or nail polish on outside diameter of plug to prevent air leaks.



M88887

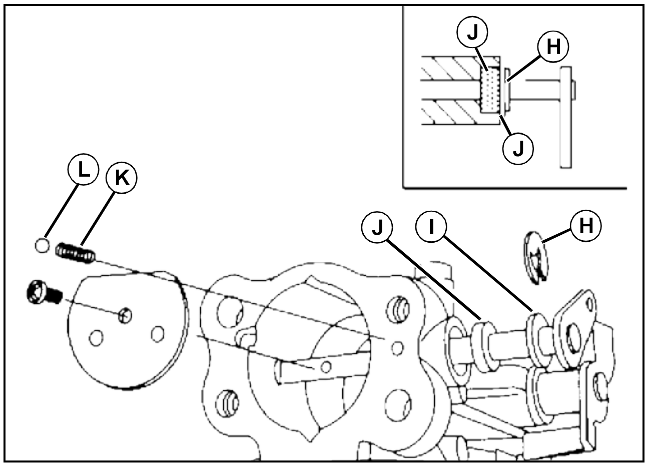
2. Install throttle shaft seal (C) with sealing lip out. Slide collar (D) over throttle shaft and insert throttle shaft through carburetor body. Place washer (E) over end of throttle shaft and install new snap ring (F).



M88888

3. Install throttle valve on shaft with numbers down (G).

With throttle valve in closed position, tighten screws securely. Then, install new welch plug in side of carburetor body. Use a round punch to tap in plug until it is flat. Use sealant on outside diameter of plug to prevent air leaks.



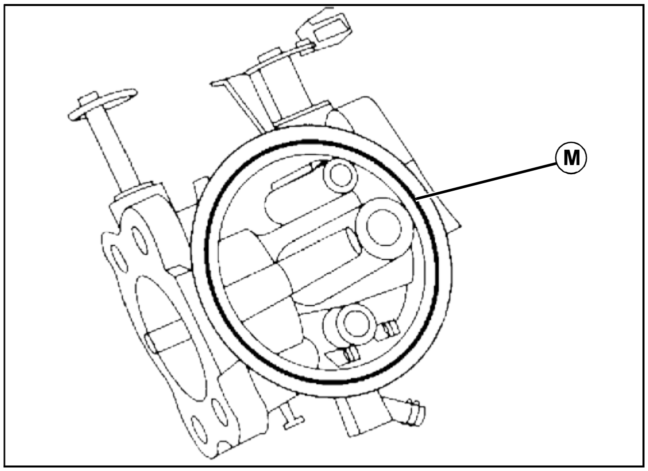
M88889

4. Install new E-ring (H), washer (I) and felt seal (J) onto choke shaft.

5. Insert spring (K) and check ball (L) in to spring pocket. Push choke shaft into hole until ball engages groove in choke shaft.

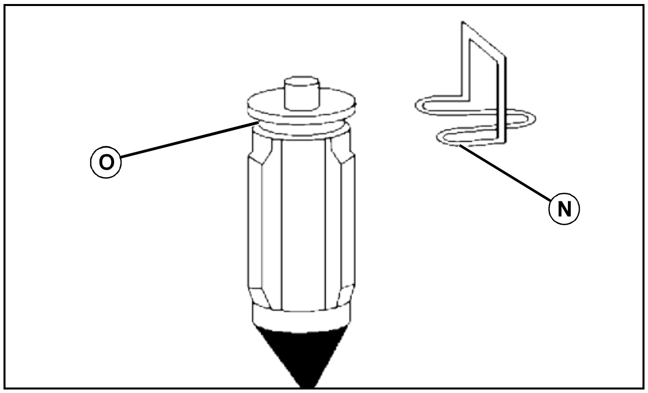
6. Place choke valve onto flat on choke shaft with flat edge of choke valve up and dimples down.

7. With choke valve in closed position, install and tighten screw securely.

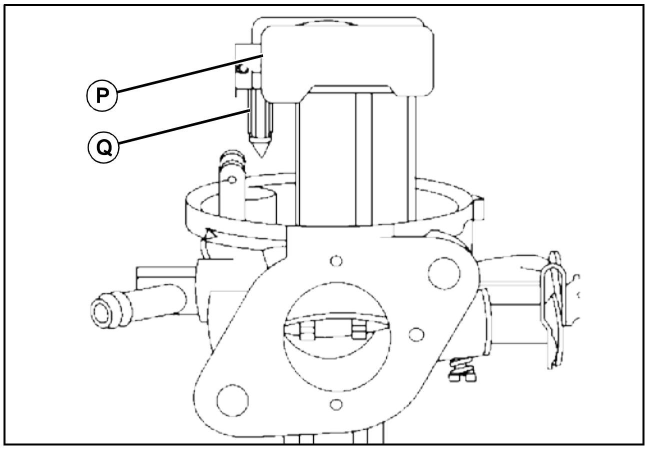


M88890

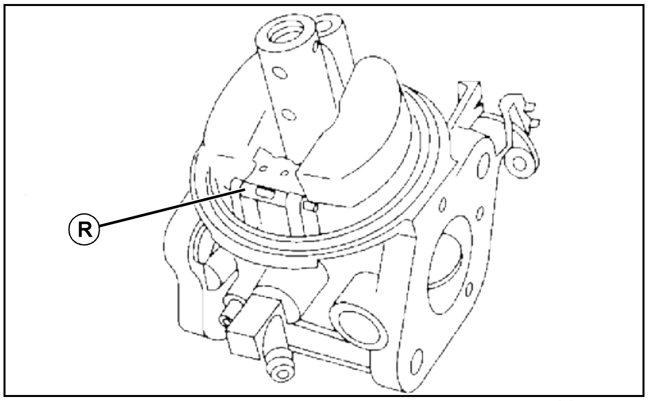
8. Install carburetor bowl gasket (M) in carburetor body groove. Make sure gasket does not twist or kink.



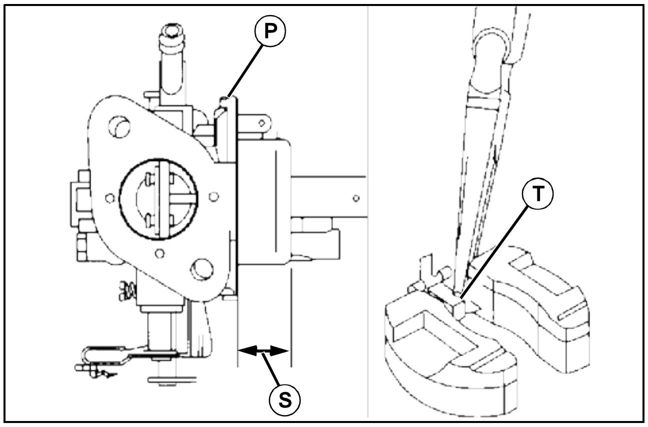
9. Install fuel inlet valve retainer (N) in fuel inlet valve groove (O).



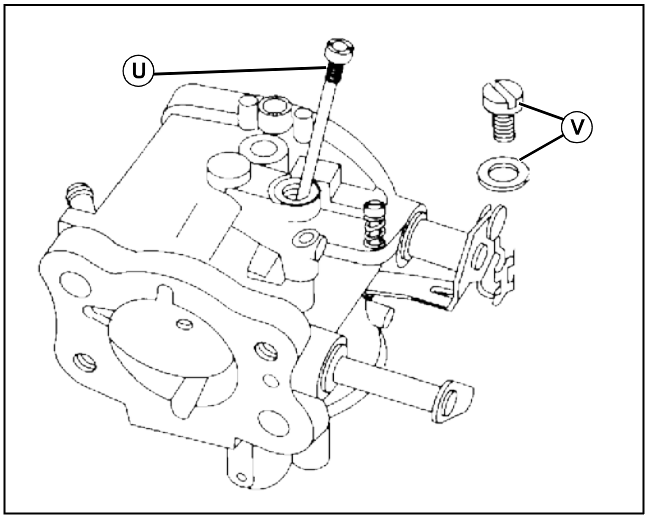
10.Slide fuel inlet valve assembly (Q) onto float tang (P). Place assembly in carburetor.



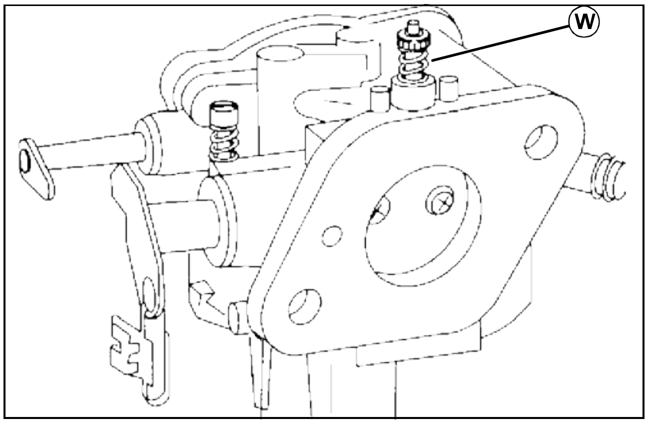
11.Install float hinge pin (R) into place.



12.Hold carburetor in vertical position, with float hinge up. The float should be parallel (S) to the carburetor bowl mounting surface. If not, bend tang (P) as shown (T). DO NOT press on float to adjust.

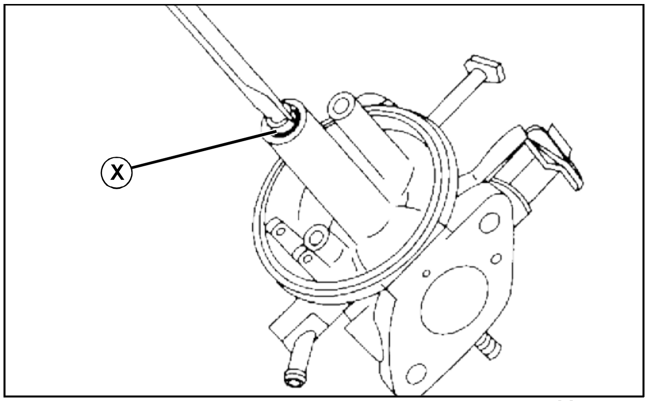


13.Install idle jet (U), and plug and gasket (V). Tighten plug securely



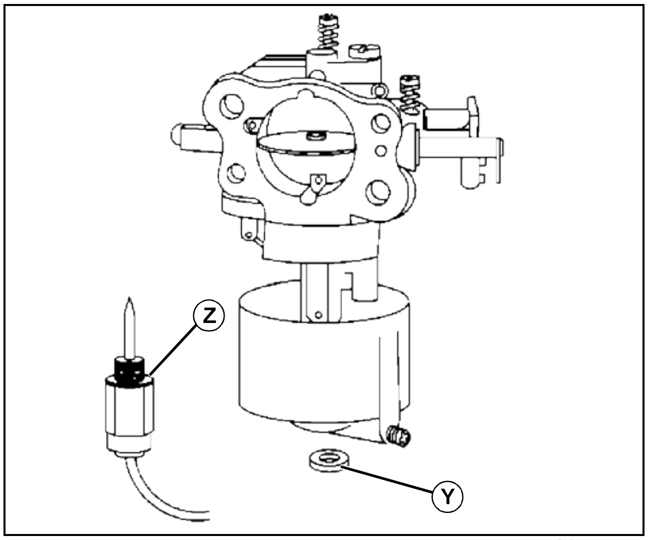
14.Install idle mixture valve with spring (W), and adjustment limiter cap.

NOTE: Special high altitude jets may be required in certain areas.



M88875

15.Install high speed nozzle and fixed main jet (X).



M94887

16.Install bowl, washer (Y) and screw or fuel shutoff solenoid (Z) and washer. Tighten to 5 N•m (45 lb-in.). Position bowl drain.

Engine Removal and Installation

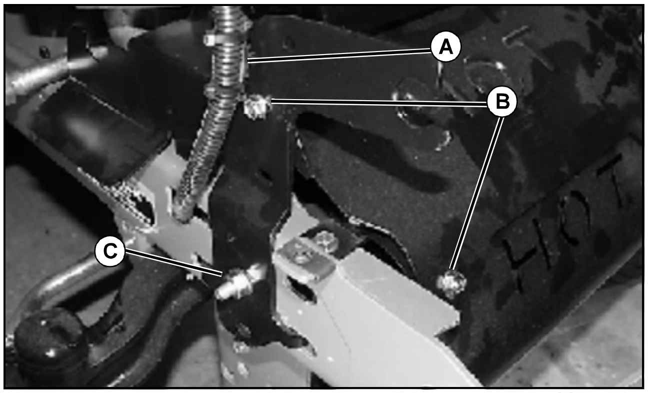
Removal:

1. Allow engine to cool before removing the engine.
2. Drain engine oil.

Oil Capacity w/o Oil Filter . . . . 1.42 L (1.5 qt)

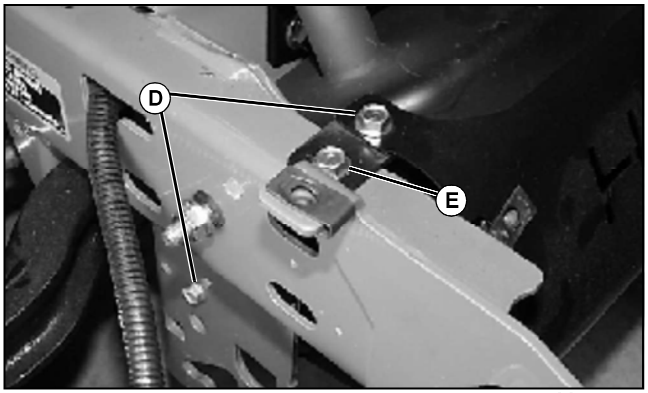
Oil Capacity w/ Oil Filter . . . . 1.65 L (1.75 qt)

3. Disconnect battery negative (-) terminal ground cable. Disconnect positive (+) battery cable. Remove battery.
4. Disconnect headlight connector and remove hood. See “Hood Removal and Installation” on page 589 in the Miscellaneous section.
5. Remove four screws securing front bumper and remove bumper.



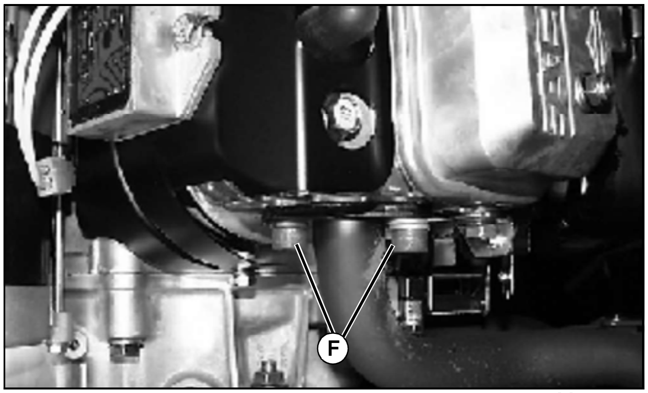
M99588

6. Remove wiring harness tie down clip (A) from left hood bracket.
7. Remove four cap screws (B) securing heat shield.
8. Remove left and right side flange nuts (C) securing hood brackets to frame. Remove hood brackets
9. Remove top heat shield.



M99592

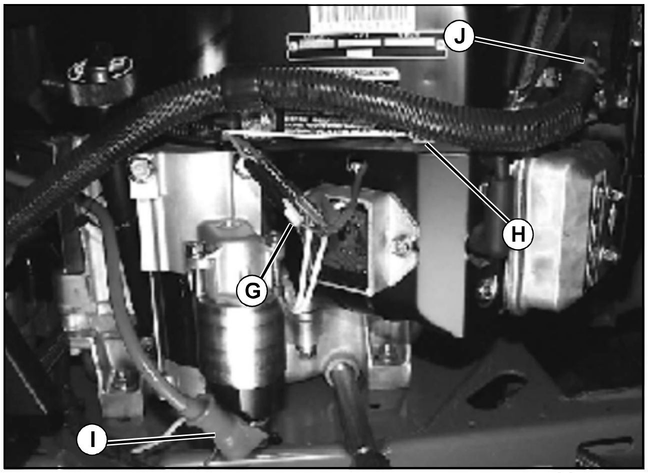
10.Remove four cap screws (D) securing lower heat shield, and remove heat shield. Remove two cap screws (E) securing muffler to frame.



M99593

11.Remove four allen head bolts (F) and lock washers securing muffler to engine. Remove muffler.

12.Clean muffler and engine of all old gasket material.

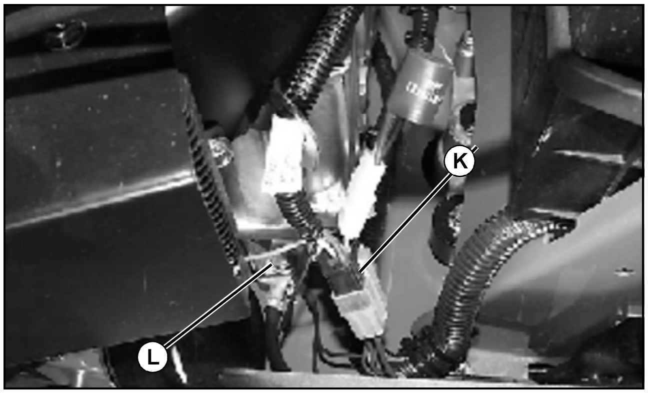


M99594

13.Disconnect engine electrical connectors (G) and white ground wire (H). Remove starting motor cable (I) and wires from starting motor.

CAUTION: Avoid injury! DO NOT SMOKE. Always work in a well ventilated area away from open flame or spark producing equipment; this includes equipment that utilizes pilot lights.

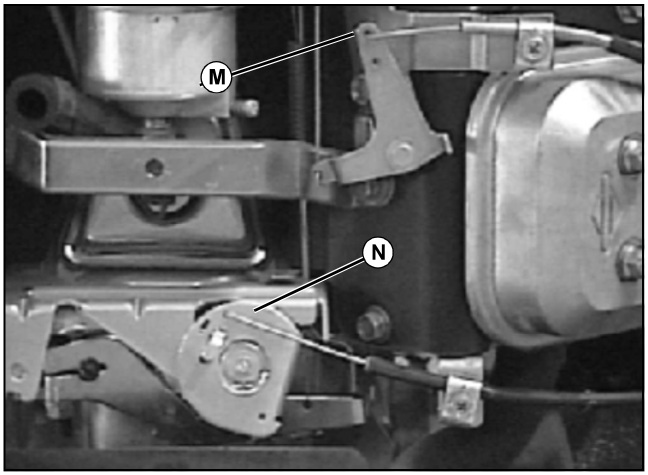
14.Disconnect fuel line (J) from fuel pump. Plug line.



M99595

15.Disconnect wiring harness connector (K) on left hand rear side of engine. Remove cap screw and ground wire (L) from engine and frame.

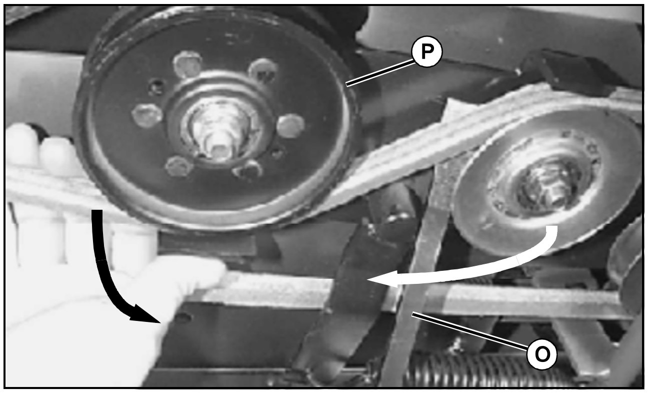
16.Remove air cleaner. See “Air Cleaner Removal and Installation” on page 203.



M92382

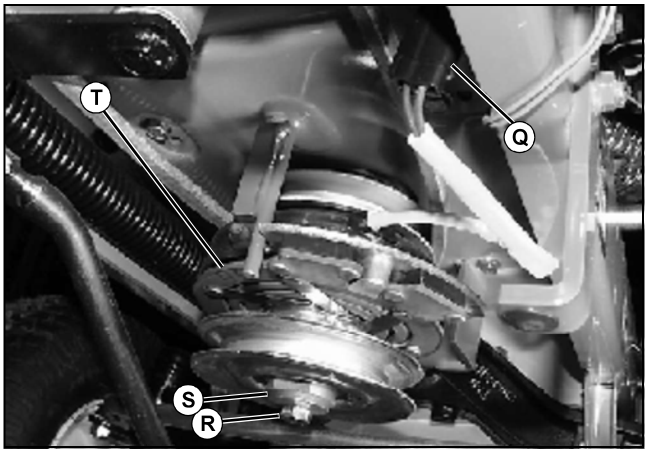
17.Disconnect choke cable (M) and throttle cable (N).

NOTE: It is not necessary to completely remove drive belt to remove engine.



M95314

18.On underside of machine, locate the traction drive belt tensioner. Using a pry bar (O), turn belt tensioner to relieve tension on belt, and slip belt off of flat idler (P).



M99596

19.Disconnect electric clutch connector (Q).

20.Remove cap screw (R), washer (S) and electric clutch (T) from engine shaft.

21.Remove electric PTO clutch. See “Electric Clutch Removal and Installation” on page 347 in the Electrical section.

22.Remove traction drive belt and sheave from engine shaft.

NOTE: Drive key is a part of the sheave. DO NOT attempt to remove key from sheave bore.

23.Remove four engine mounting bolts and engine.

Installation:

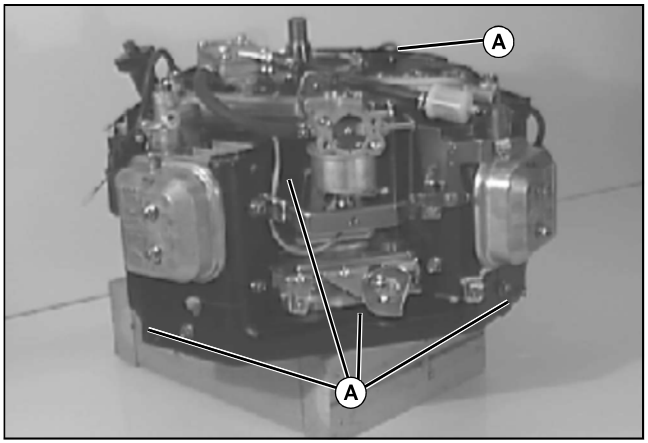
Installation is the reverse of removal:

- Tighten four engine mounting bolts and flange nuts to 32 N•m (24 lb-ft).
- Install electric clutch. Tighten clutch bolt to 75 N•m (55 lb-ft).
- Install traction drive belt. See “Traction Drive Belt Removal and Installation” on page 439 in the Power Train section.
- Inspect muffler flanges for flatness. Install muffler with new gaskets. Tighten exhaust manifold bolts to 17 N•m (150 lb-in.).

Cylinder Air Guides Removal and Installation

Removal:

1. Remove upper blower housing. See “Upper Blower Housing Removal and Installation” on page 202.
2. Remove air filter assembly. See “Air Cleaner Removal and Installation” on page 203.
3. Remove carburetor. See “Carburetor Removal and Installation” on page 203.



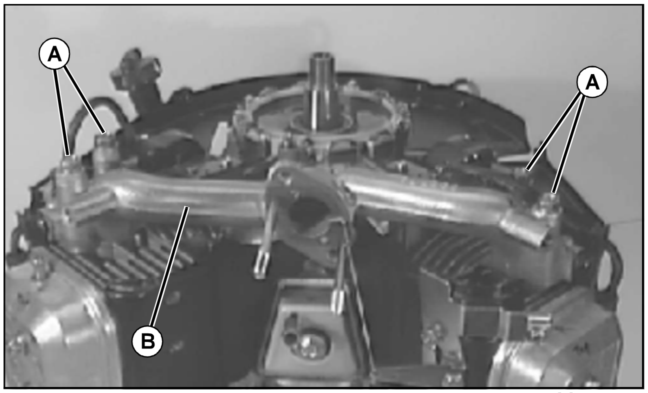
M88980

4. Remove front and side cylinder air guides (A).
5. Install right, front and side cylinder air guides.
6. Install carburetor.
7. Install carburetor linkage
8. Install air filter assembly.
9. Install upper blower housing.

Intake Manifold Removal and Installation

1. Remove upper blower housing. See “Upper Blower Housing Removal and Installation” on page 202.
2. Remove air filter assembly. See “Air Cleaner Removal and Installation” on page 203.
3. Remove carburetor. See “Carburetor Removal and Installation” on page 203.

NOTE: Replace intake manifold and carburetor gaskets.



M88979

4. Remove intake manifold bolts (A) and intake manifold (B).

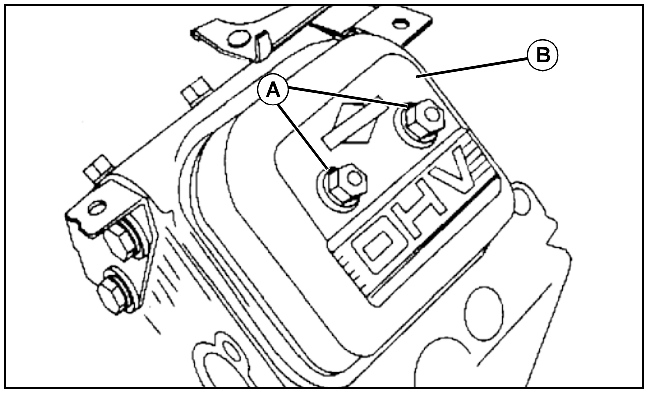
Installation:

Installation is the reverse of removal.

Cylinder Head Removal and Installation

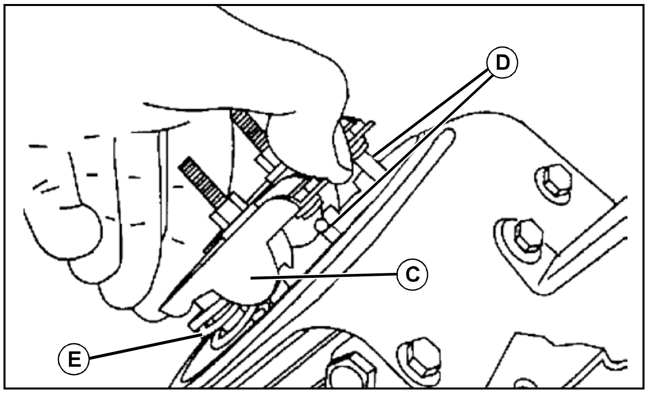
IMPORTANT: Avoid damage! Mark all parts when disassembling cylinder heads to prevent interchanging.

1. Disconnect spark plug leads and remove spark plugs.
2. Remove intake manifold. See “Intake Manifold Removal and Installation” on page 212.
3. Remove cylinder air guides. See “Cylinder Air Guides Removal and Installation” on page 212.



M87033

4. Remove seals and nuts (A), and valve cover (B).

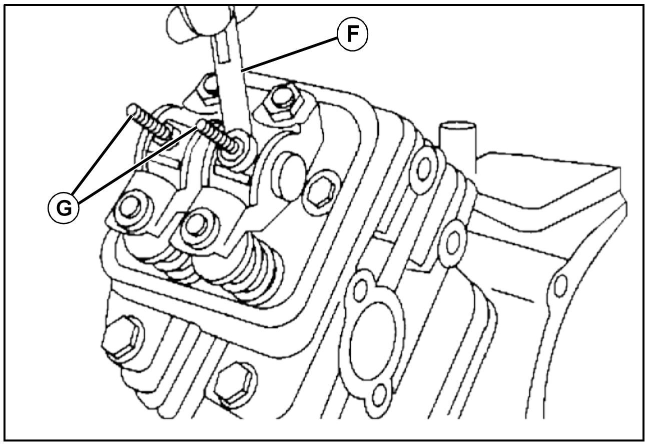


M89840

NOTE: To release spring pressure from rocker arms (C), rock the arm against spring pressure and allow push rod (D) to drop out of the rocker arm socket. Push rod will move out of position, releasing valve spring (E) pressure.

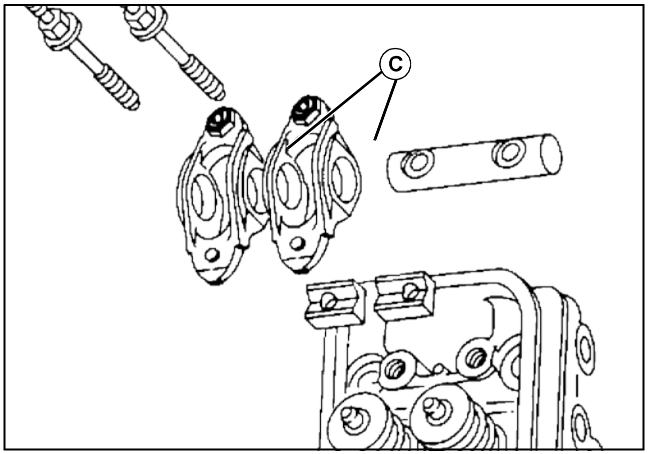
5. Release valve spring pressure

IMPORTANT: Avoid damage! Exhaust valve push rods are aluminum. Intake valve push rods are steel. Mark push rods for correct reinstallation.



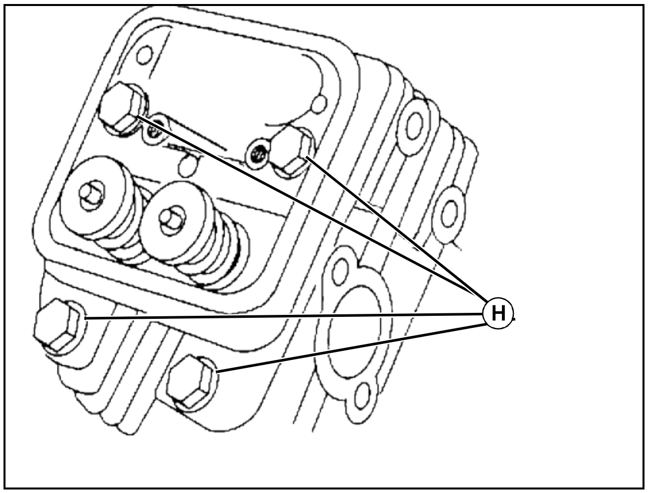
M87021

6. Using a 10 mm wrench (F), remove rocker studs (G).



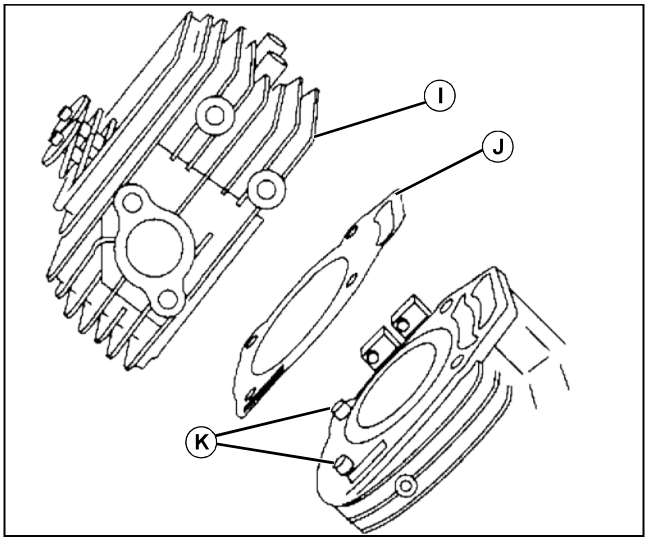
M87022

7. Remove rocker arms (C).
8. Lift out push rods.



M87023

9. Remove cylinder head bolts (H).



M87024

10.Remove cylinder head (I) and gasket (J).

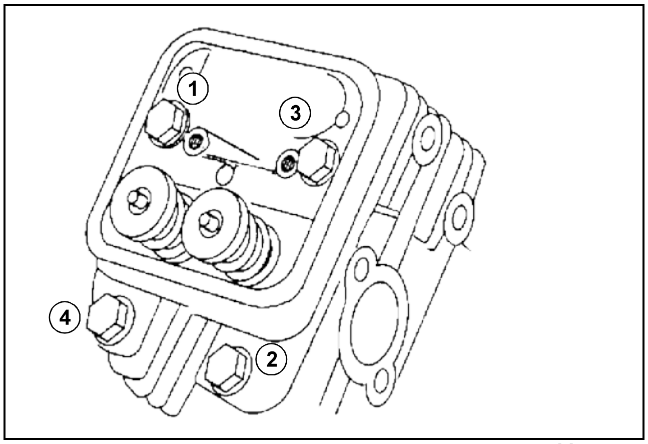
Installation:

1. Clean gasket surfaces.

2. Place new gasket and cylinder head on cylinder. Align head with cylinder head alignment sleeves (K) located in the cylinder.

3. Apply approved lubricant to threads and install four cylinder head bolts.

IMPORTANT: Avoid damage! Do not use sealer of any kind on gaskets.



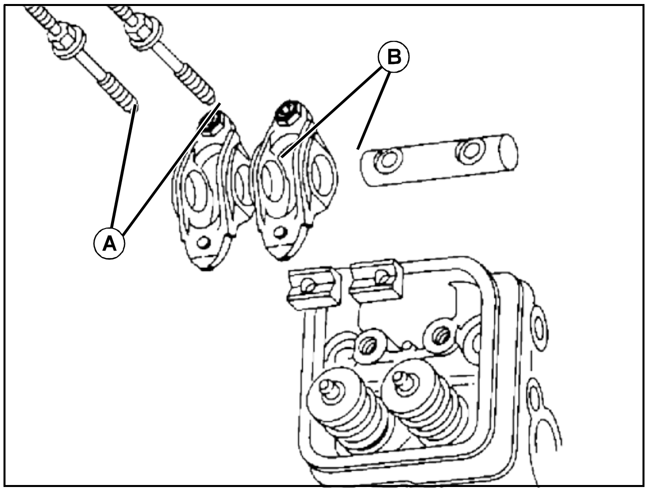
M87023

4. Tighten four head bolts down evenly by hand. Use a torque wrench to tighten cylinder head bolts in 6 N•m (55 lb-in.) increments in the sequence shown to 19 N•m (165 lb-in.).

IMPORTANT: Avoid damage! Do not tighten one head bolt to the final torque before all of the other head bolts have been tightened to the second torque. Uneven tightening may cause a warped cylinder head.

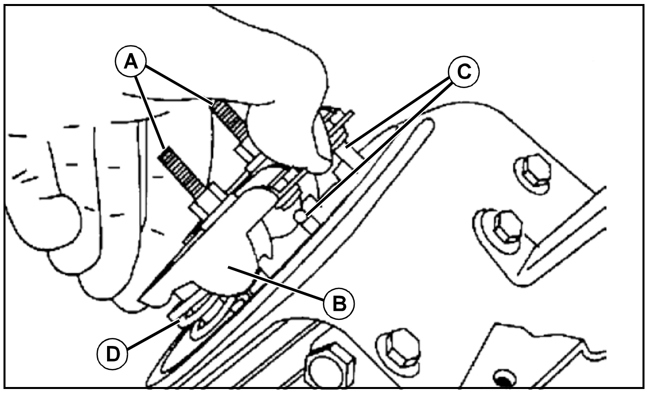
5. Insert push rods into recess in tappets.

IMPORTANT: Avoid damage! Exhaust valve push rods are aluminum. Intake valve push rods are steel. Return the push rods to their original location.



M87022

6. Assemble rocker arms (B) with rocker studs (A), to the cylinder head.

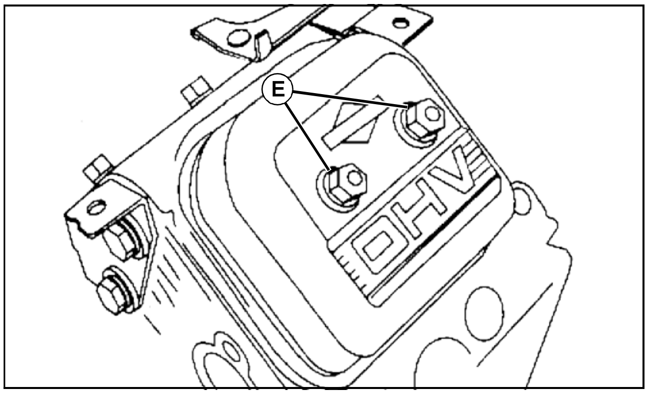


M89840

7. Compress valve spring (D) with rocker arm (B). Insert push rod (C) into rocker arm socket. Be sure push rods remain seated in recess in tappets.

8. Tighten rocker studs (A) to 16 N•m (140 lb-in.).

9. Adjust valves. See "Valve Clearance Adjustment" on page 201.



M87033

10.Install gasket and valve cover. Place seal washers and nuts (E) on studs.

11.Install intake and exhaust manifold, governor control bracket, cylinder air guides, valley cover, blower housing and air cleaner assembly.

12.Install spark plugs. Tighten to 20 N•m (180 lb-in.).

13.Install spark plug leads.

Cylinder Head Inspection and Repair

Procedure:

1. Remove combustion chamber deposits from combustion chamber and around valves using a soft, hand wire brush or scraper. With piston at TDC, remove combustion chamber deposits from top of piston.

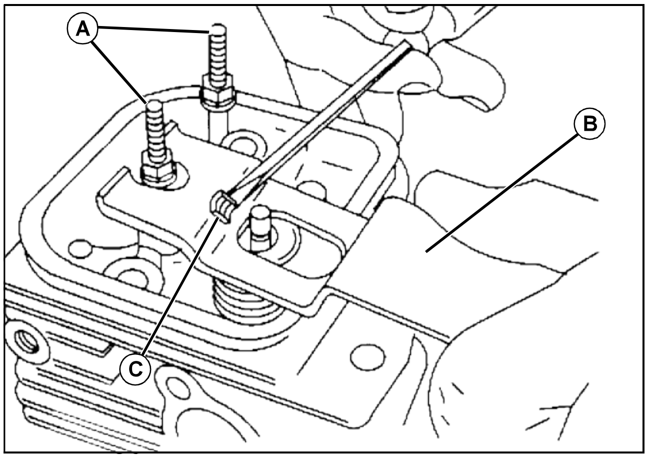
IMPORTANT: Avoid damage! Use care to prevent combustion chamber deposits from entering push rod or oil return cavity in cylinder. Take care not to damage cylinder, top of piston, cylinder head and cylinder head gasket surfaces. Remove only the combustion chamber deposits. It is not necessary to remove the discoloration marks on the piston, valves and cylinder head. These marks are normal and will not affect engine operation.

2. Inspect cylinder head for broken fins or cracks. Repeat procedure for other cylinder head and cylinder.

Valve Removal

Procedure:

1. Remove the valves, place cylinder on workbench with support to hold valves in place.



M87025

2. Reinstall rocker studs (A) into cylinder head. Do not tighten. Slip end of valve spring compressor (B) under stud of valve spring. Press down on tool handle to compress valve spring and remove split retainers (C).

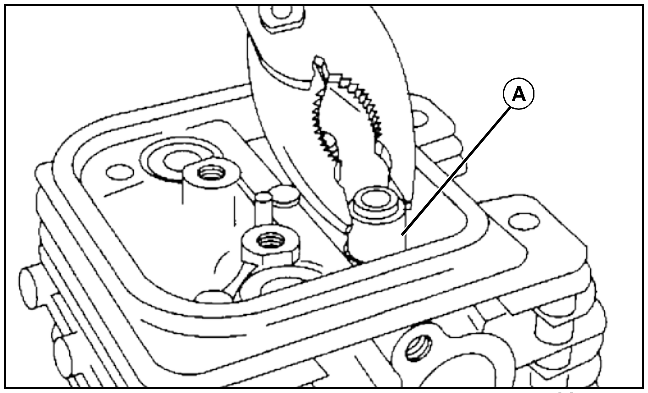
3. Release pressure and remove retaining washer and spring.

4. Remove rocker studs.

5. Repeat procedure on other cylinder head.

Valve Inspection and Repair

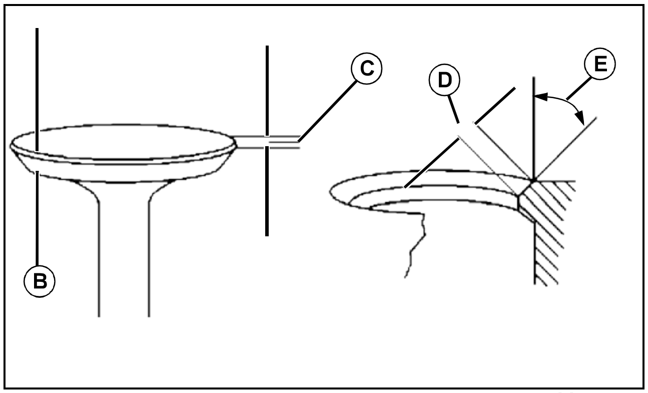
Procedure:



M87026

1. To remove valve stem seals (A), grasp seal with pliers and pull up on seal while turning.

IMPORTANT: Avoid damage! Always replace valve stem seals whenever valves are removed for servicing.



M87027

2. Faces on valves may be resurfaced with a valve grinder to 45° (E). Valve seats can be reconditioned using valve seat cutter. Valves and seats should then be lapped with valve lapping tool and valve lapping compound. Remove grinding marks and assure a good seal between valve and seat. Thoroughly clean lapping compound from valve seat and valve face.

3. Valve margin (B) should be 0.8 mm (0.031 in.) (C). If 0.4 mm (0.016 in.) or less, resurface or replace valve.

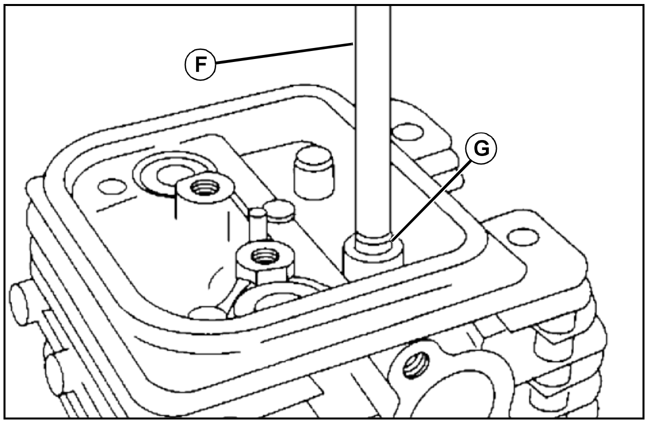
4. Valve seat width (D) should be 1.2 - 1.6 mm (0.047 - 0.063 in.).

5. If seat is wider, it may be narrowed using valve seat cutter. Use 30° side of cutter to narrow the seats. If the valve is badly burned, it should be replaced. Replace valve

if margin is badly burned; if damaged, replace cylinder head. Valve seats are not replaceable.

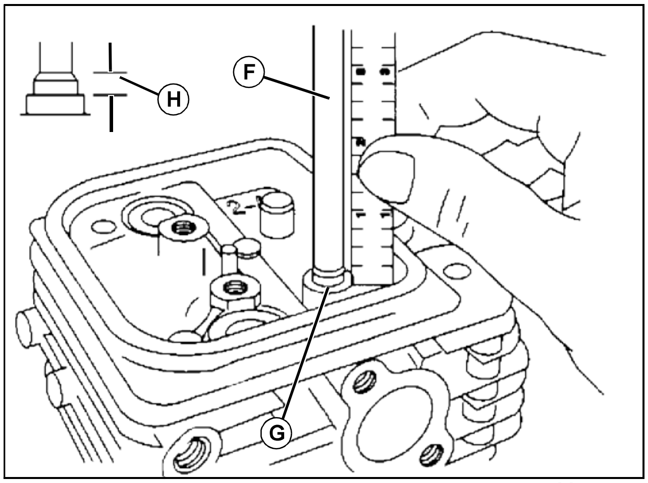
6. Inspect valve springs and replace if broken or worn.

7. Inspect valve guides by inserting plug gauge into valve guide. If plug gauge inserts 6.4 mm (0.25 in.) or more, the guide must be replaced. If plug gauge is not available, the reject dimension for both valve guides is 6.05 mm (0.238 in.).



M87028

8. To remove valve guides (G), use bushing driver (F). Support cylinder head and press out valve guide.

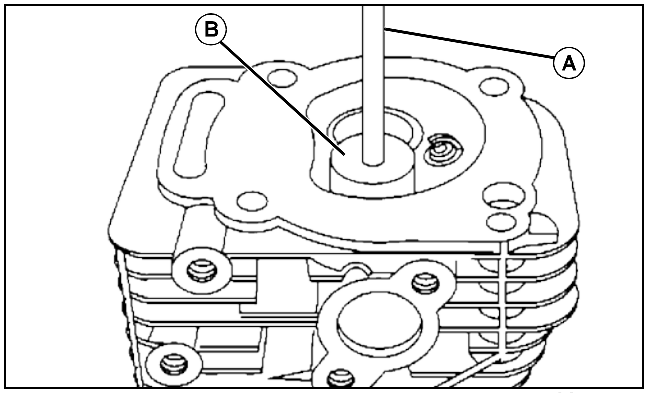


M87029

9. To install new valve guides (G), place new valve guide on bushing driver (F). Valve guide can be installed either way. Press in valve guide to dimension (H) 7.0 mm (0.276 in.).

Valve Guide Ream

Procedure:



M87030

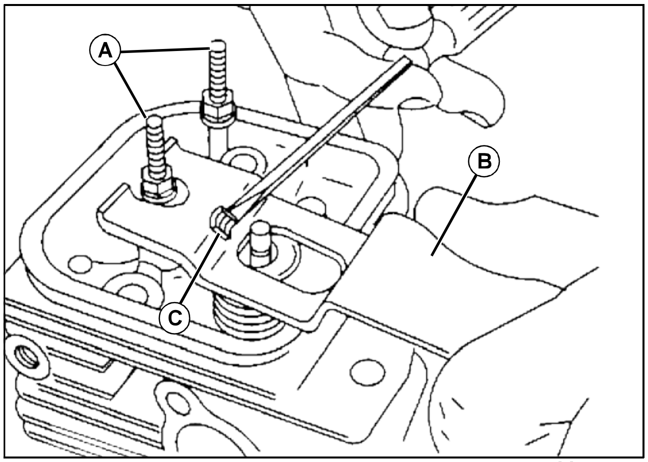
1. To ream valve guides, use finish reamer (A) and reamer pilot guide (B) to finish ream valve guide. Use oil, Stanisol or kerosene to lubricate reamer. Ream through entire guide. Keep turning reamer clockwise when removing reamer. Flush out all chips.

IMPORTANT: Avoid damage! Insure valve guide lubricant is not on valve face, seat or end of valve stem.

2. Install new seals over valve guides. Press down on seal until it bottoms. Valve stems must be free of foreign material and burrs or sticking will occur and valve stem seals will be damaged. Be sure valve guides are free of foreign materials and burrs. Lightly coat valve stems with valve guide lubricant and insert valves into valve guides.

Valve Installation

Procedure:



M87025

1. Install springs and valve spring retainers over valve stems. Temporarily install rocker studs (A) in cylinder head.

2. With valve spring compressor (B), compress spring and install split retainers (C). Repeat procedure for other valves.

3. Remove rocker studs.

Piston, Rings and Rod Removal and Installation

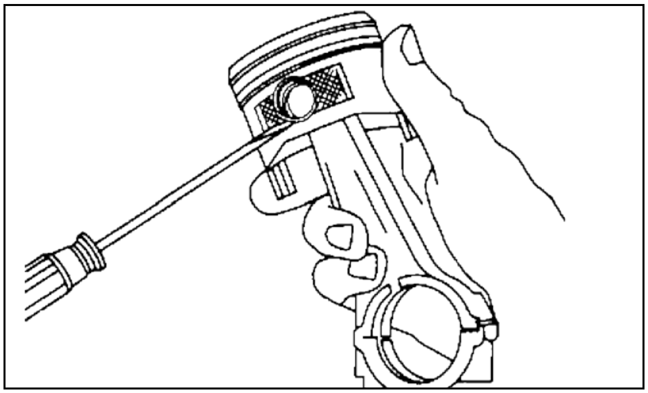
Procedure:

1. Remove air filter and bracket, upper blower housing, flywheel, alternator, carburetor, intake manifold and governor linkage.

2. Remove starting motor, cylinder heads and crankcase cover.

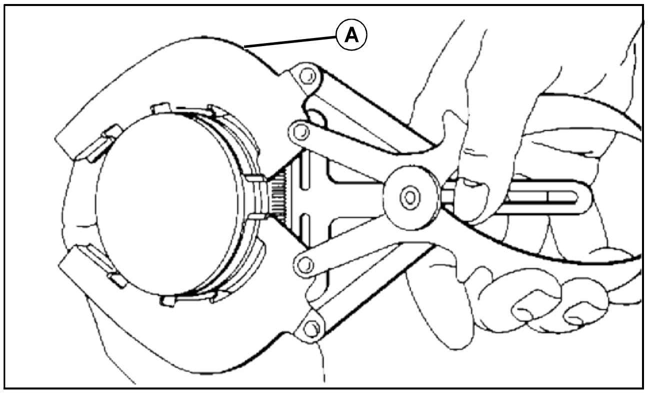
NOTE: Remove any carbon or ridge at the top of the cylinder bore. This will prevent breaking the rings when removing the piston and connecting rod from the engine.

3. Remove the connecting rod cap. Then push the piston and connecting rod out through the top of the cylinder.



M87036

4. To remove connecting rod from piston, remove piston pin locks with screwdriver. Piston pin is a push fit in piston and rod. Deposits may build up on piston pin and require the piston pin to be pressed out.



M86904

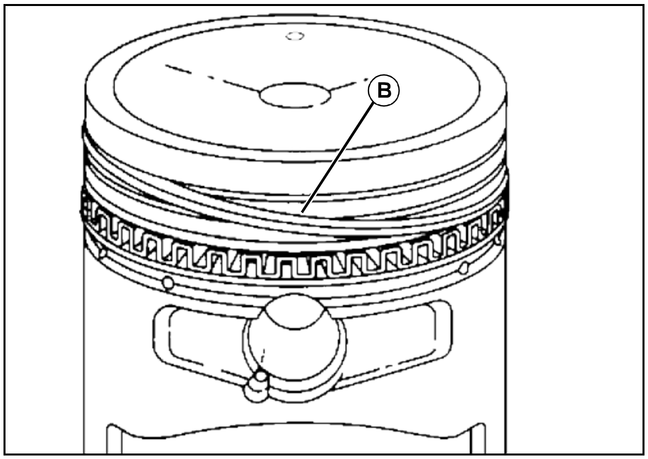
IMPORTANT: Avoid damage! Remove top and center compression rings using ring expander (A). New piston rings must be installed whenever the engine is disassembled for major servicing or overhaul, providing that cylinder bores are within specifications.

NOTE: Measure cylinder bores before checking pistons and rings. If cylinder bores require re-sizing it will not be necessary to check pistons and rings since a new oversized piston assembly must be used.

5. If cylinder bore is more than 0.08 mm (0.003 in.) oversize, or 0.04 mm (0.002 in.) out of round, it must be resized.

IMPORTANT: Avoid damage! When servicing pistons, rings, piston pins or rods, each rod, piston, piston pin and ring set must be kept as a set for the cylinder that it was removed from. Mark each set before removing from the engine.

NOTE: Oil control ring (B) is shown being spiraled into compression ring groove.



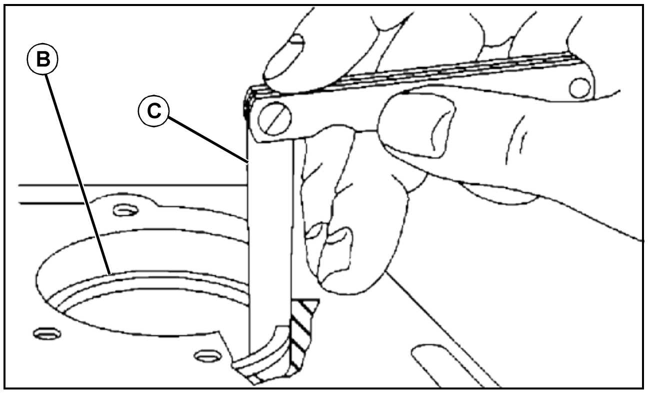
M87038

6. Spiral top oil control ring from oil ring groove into center compression ring groove. Repeat into top compression ring groove, and then off piston. Repeat for bottom oil control ring.

NOTE: If the cylinder is to be resized, there is no reason to check the piston, since a new oversized piston assembly must be used. If however, the cylinder is not to be resized and the piston shows no signs of wear or scoring, only the piston rings must be replaced.

Checking End Gap

1. Insert old rings one at a time approximately 25.4 mm (1.0 in.) down into a cylinder bore.



M86906

2. Check end gap with feeler gauge (C). If ring gap is greater than 0.80 mm (0.030 in.) for compression and oil ring (B), the ring is worn and should be replaced.

CAUTION: Avoid injury! Note that the top and bottom edges of the ring may be extremely sharp. Never reuse worn piston rings.

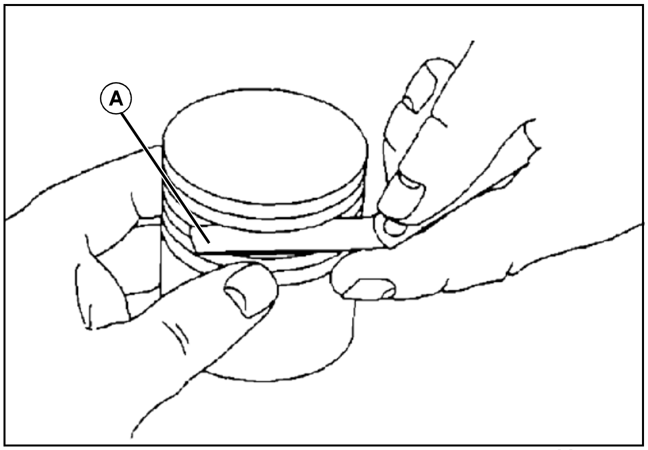
NOTE: Before installing new piston rings, the cylinder bore should be reconditioned using a rigid hone with finishing stones. This will restore the proper cross hatch angle in the cylinder bores. The correct cylinder cross hatch ensures proper lubrication and piston ring rotation.

3. A worn ring will usually show scratches caused by abrasives and/or have a shiny appearance. Never reuse worn piston rings.

Piston Inspection

Procedure:

1. Clean carbon from top two ring grooves.
2. Place a new ring in each piston groove.

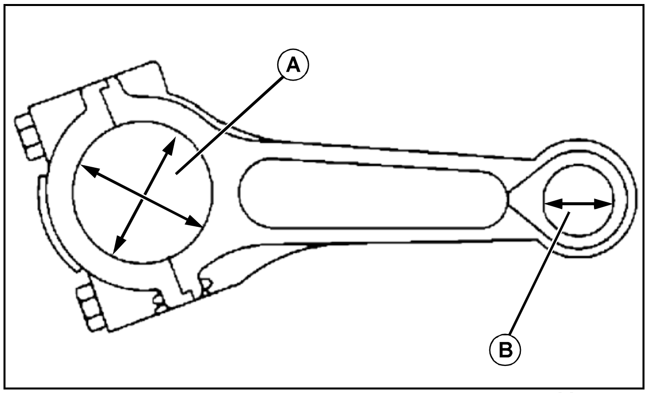


M86905

3. If a 0.10 mm (.004 in.) or larger feeler gauge (A) can be inserted in the compression ring grooves, or a 0.20 mm (.008 in.) or larger feeler gauge can be inserted in the oil ring grooves, the compression and ring grooves are worn and the piston should be replaced.

Connecting Rod Inspection

Procedure:



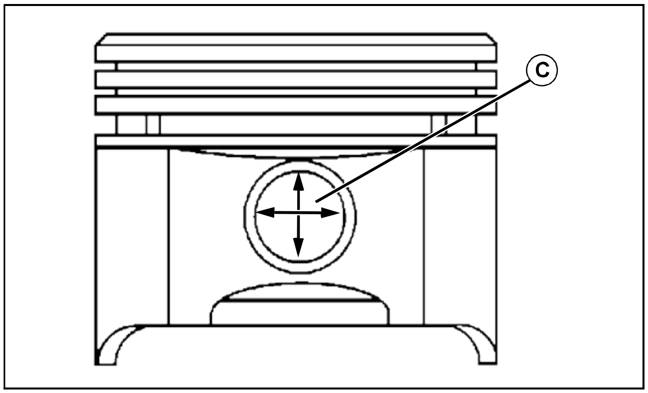
M88925

1. If the crankpin bearing (A) in the connecting rod is scored, the rod must be replaced. Reject size of crankpin bearing and piston pin bearing (B) is:

Wear Limit

Crankpin Bearing . . . . 37.12 mm (1.461 in.)

Piston Pin Bearing . . . . 17.12 mm (0.674 in.)



M88926

2. Replace connecting rod if either bore is worn.

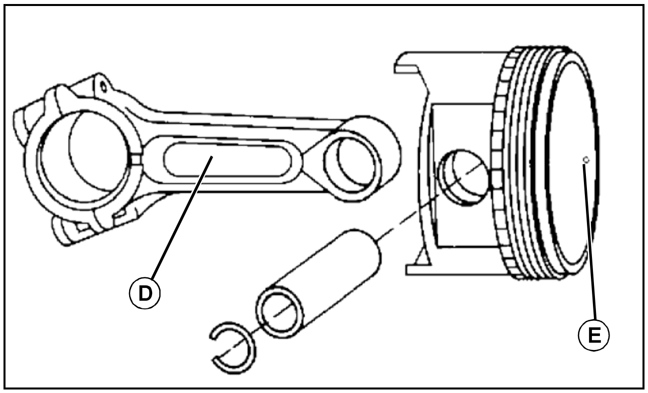
3. Reject sizes for piston pin and piston pin bore (C) are as follows:

Specifications

Piston Pin . . . . 17.06 mm (0.672 in.)

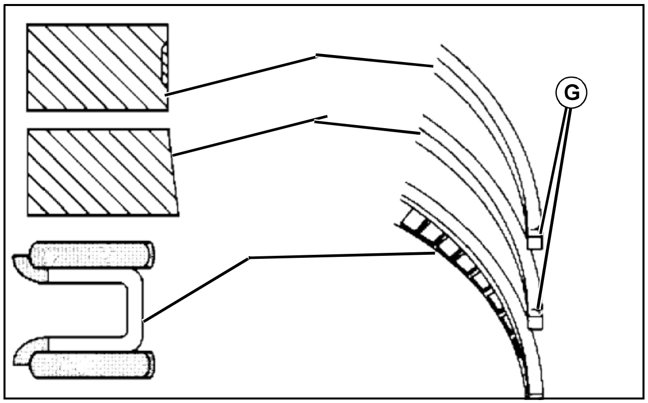
Piston Pin Bore . . . . 17.12 mm (0.674 in.)

4. If piston pin is worn 0.01 mm (0.0004 in.) out of round or below reject size, it must be replaced.



M88927

5. The piston pin is a slip fit in both piston and connecting rod. Use a thin nose pliers or screwdriver and install a piston pin lock in groove on one side of piston. Refer to above drawing to determine correct location of rod ("Out 1" cylinder number one, or "Out 2" cylinder number two) (D) in relation to notch or circle (E) on piston. Insert piston pin from opposite side of piston until pin stops against piston pin lock. Then install other piston pin lock. Be sure both locks are seated in grooves.

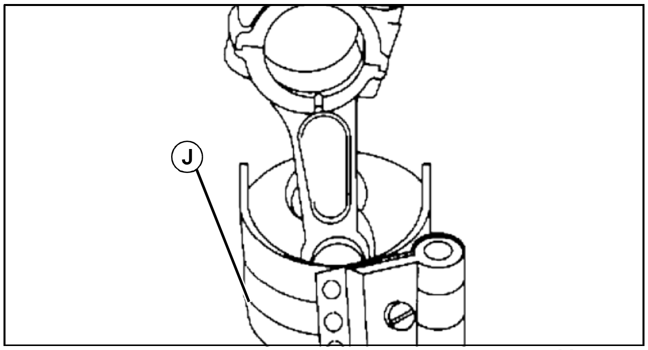


M88928

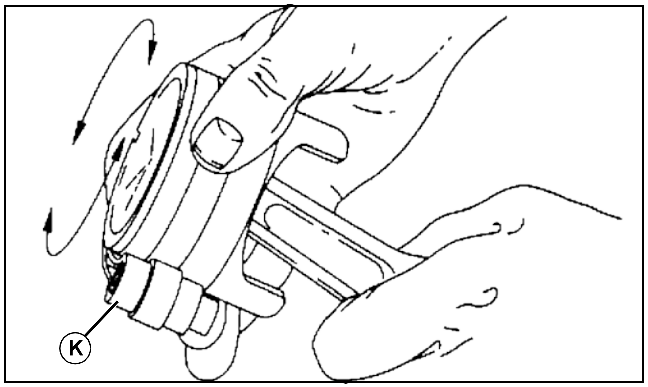
6. The correct piston ring positions are shown above. The oil ring is installed with the expander (F) between the two oil control rings. The top and second compression rings are installed with "ID" mark (G) toward top of piston.

7. Install expander first. Spiral bottom oil control ring into top ring groove, then into second ring groove and into position below expander. Repeat procedure for top oil control ring.

8. Using ring expander, install center compression ring (taper face) (H) then, top compression ring (barrel face) (I) as shown above.



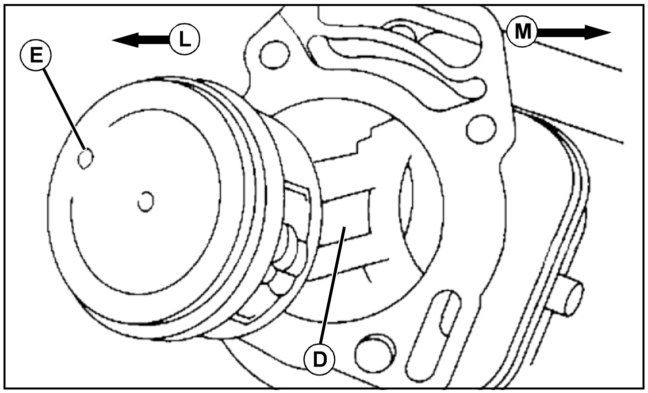
M88929



M88930

9. Apply oil to piston rings and piston skirt. Compress rings with ring compressor tool (K). Place piston and ring compressor upside down on bench. Push down until head of piston and edge of ring compressor are even. Tighten ring compressor until rings are fully compressed. Then loosen ring compressor very slightly so that compressor can be rotated on piston skirt while holding connecting rod.

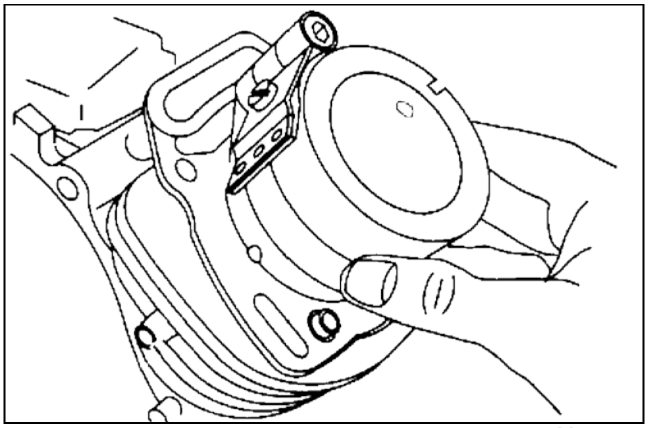
NOTE: Approximate location of projections (J) on ring compressor shown above. These will be inserted to the cylinder bore when assembling piston to cylinder.



M88931

10.Thoroughly clean and oil cylinder bore. Rotate crankshaft until crankpin journal is at bottom of stroke. This permits complete entry of compressed rings, piston and rod assembly, when pushed into cylinder. If other piston and rod assembly was removed, repeat procedure for that cylinder.

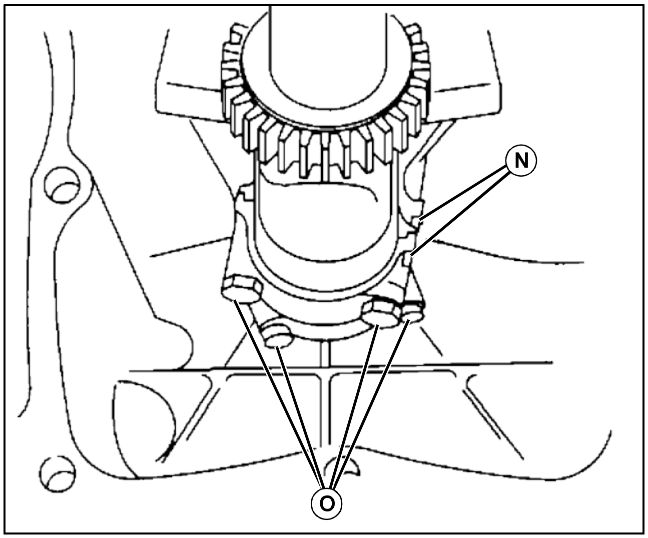
NOTE: The pistons have offset piston pin bores. When the circle on piston (E) is facing toward the flywheel side (L) of engine, the words "OUT-1" on the side of the connecting rod for cylinder No. 1 and "OUT-2" on the side of the connecting rod for cylinder No. 2 (D) should face toward the PTO side (M) of the crankcase.



M88932

11.Clean and oil crankshaft crankpin.

12.Pull connecting rod against crankpin.



M88933

13.Install rod cap with match marks (N) aligned.

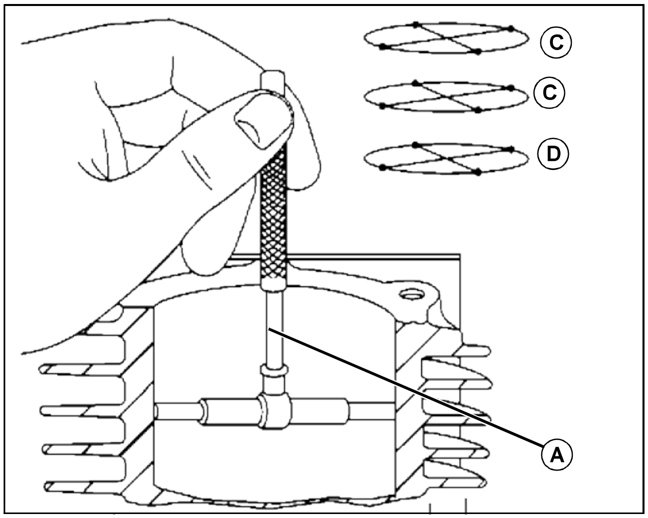
NOTE: Failure to use a torque wrench can result in loose connecting rods causing breakage, or tight connecting rods causing scoring.

14.Install connecting rod bolts (O) and tighten to 11 N•m (100 lb-in.).

15.Rotate crankshaft two revolutions to check for binding. Rod should also be free to slide sideways on crankpin.

Cylinder Bore Inspection

Procedure:



M86883

1. Always inspect cylinder after engine has been disassembled. Visual inspection will show if there are any cracks, stripped bolt holes, broken fins or if the cylinder walls are damaged. Use a telescoping gauge (A) and a dial caliper, or use an inside micrometer to determine the size of the cylinder bore. Measure at right angles at six locations from the top (B), middle (C) and bottom (D).

Specifications

Standard Bore Size

Minimum . . . . 72.0 mm (2.835 in.)

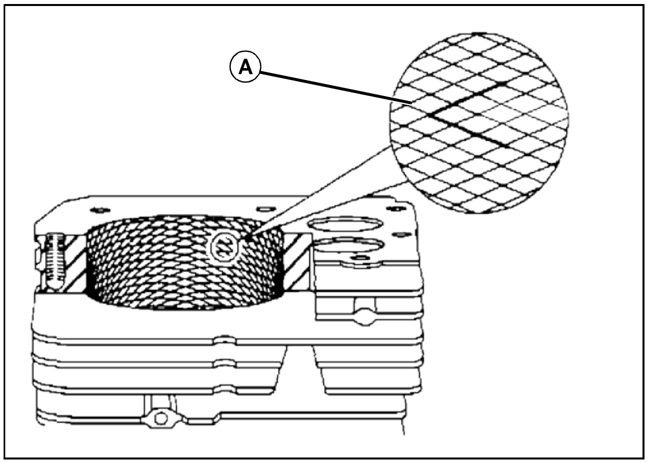
Maximum. 72.025 mm (2.836 in.)

2. If the cylinder bore is more than 0.08 mm (0.003 in.) oversize, or 0.04 mm (0.002 in.) out of round, it must be resized, or replaced. See "Resizing Cylinder Bore" on page 221.

3. If cylinder bores are within specification and show no signs of scoring or other damage, new piston rings may be installed providing the cylinder bores are reconditioned using a rigid hone with finishing stones. This is necessary to restore the cross hatch angle in the cylinder bores, and ensure proper lubrication and piston ring rotation.

Cylinder Bore Honing

Procedure:



M86885

1. The cross hatch cylinder finish should be applied after cylinder bore has been resized to within 0.038 mm (0.0015 in.) of the desired size or when reconditioning a cylinder bore. The finishing stones will produce the correct cross hatch necessary for proper lubrication and piston ring rotation. The correct hatch angle is approximately 45° (A).

2. It is recommended that the cylinder bores be reconditioned to restore the cross hatch when new piston rings are to be installed in a cylinder that is within specification. Be careful not to hone oversize or it will be necessary to resize the cylinder.

NOTE: To produce the proper cross hatch finish use a drill speed of approximately 200 rpm and 40 - 60 strokes per minute. Lubricate hone liberally to prevent build up on finishing stones.

Cylinder Bore Cleaning

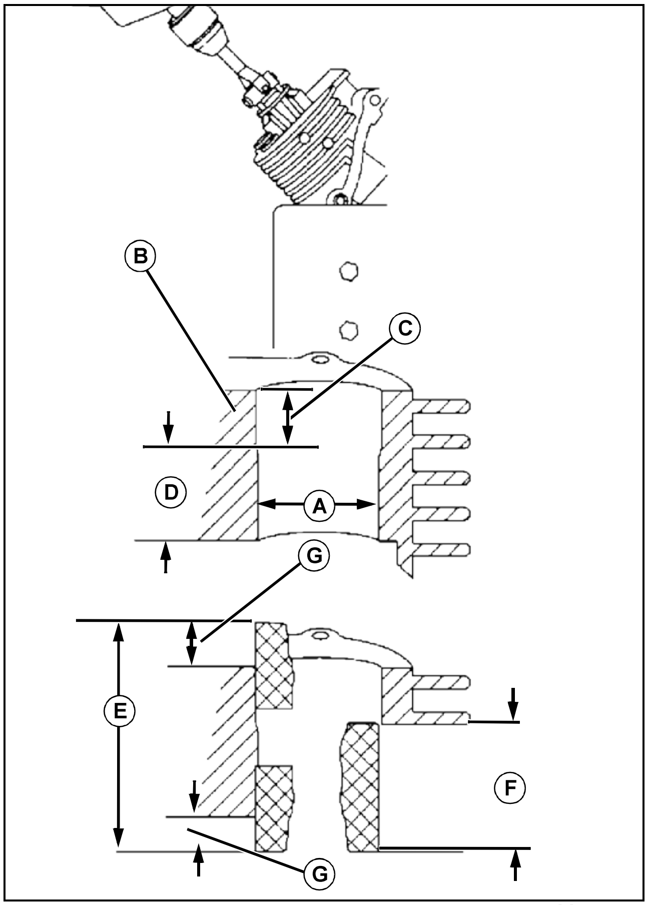
IMPORTANT: Avoid damage! Ensure that the entire cylinder and crankcase are thoroughly cleaned after honing. First wash the cylinder and crankcase carefully in a solvent such as kerosene or commercial solvent. Then thoroughly wash cylinder and crankcase using a stiff brush with soap and hot water, Rinse thoroughly with hot running water. Repeat washing and rinsing until all traces of honing grit are gone. Honing grit is highly abrasive and will cause rapid wear to all of the internal components of the engine unless it is completely removed.

Procedure:

1. When the cylinder and crankcase have been thoroughly cleaned, use a clean white rag or napkin to wipe the cylinder bore. If honing grit is present it will appear as a gray residue on the rag. If any honing grit is evident, re-wash and rinse entire cylinder and crankcase and check again. When there is no trace of honing grit on the rag, the cylinder is properly cleaned. Oil the cylinder bore to prevent rusting.

Resizing Cylinder Bore

Procedure:



M88942

1. If the cylinder bore is not within specifications, it will have to be resized using a boring bar or hone. Always resize to exactly 0.51 mm (0.020 in.) over standard size.

Specifications:

Standard Bore Size

Minimum . . . . 72.0 mm (2.835 in.)

Maximum. . . . . 72.025 mm (2.836 in.)

2. If this is done accurately, the service oversize rings and pistons will fit correctly, maintaining proper clearances.

IMPORTANT: Avoid damage! If a boring bar is used, a hone must be used after the boring operation to produce the proper cylinder cross hatch.

3. If a hone is used to resize the cylinder bore, place hone in middle of cylinder bore (A). Tighten adjusting knob with finger until stones fit snugly against cylinder wall. DO NOT FORCE.

4. Connect driveshaft to hone. Be sure that cylinder and hone are centered and aligned with driveshaft and drill spindle. Lubricate hone as recommended by hone manufacturer.

5. The recommended drill speed is 300 to 700 rpm maximum and 40 - 60 strokes per minute.

6. Because cylinder bores normally wear (B) only in the area of ring travel (C), the cylinder bore will be round above and below ring travel (D).

7. Start drill and, as hone spins, move it up and down at the bottom of the cylinder bore.

8. Gradually increase the length of the strokes until hone travels full length of cylinder bore (E), with a starting point below the wearing of ring travel (F). Do not travel more than 19.05 mm (0.750 in.) to 25.4 mm (1.0 in.) (G) above cylinder bore.

9. Lubricate hone frequently to prevent build up on stones.

10.As cutting tension decreases, stop hone and tighten adjusting knob following hone manufacturer's recommendations.

11.Check cylinder bore size frequently.

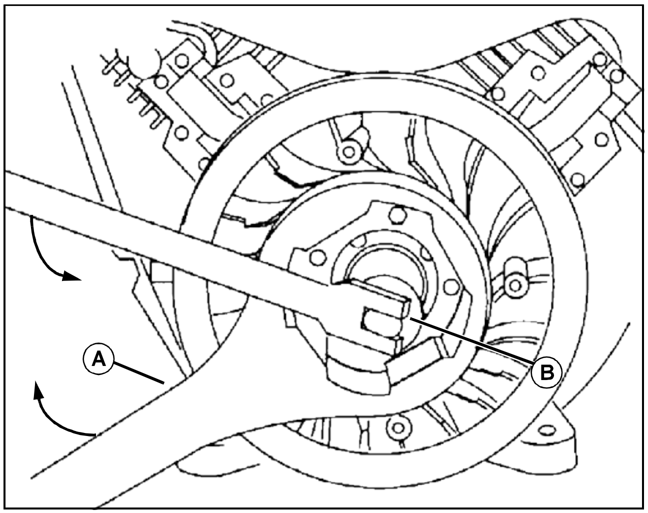
12.Check cylinder bores at top and bottom for burrs. Remove burrs. Cylinder head and crankcase cover surfaces must be free of burrs and gasket material.

13.After cylinder bore has been brought to proper resizing dimension, a cross hatch must be applied to bore. See "Cylinder Bore Honing" on page 221.

Flywheel Removal and Installation

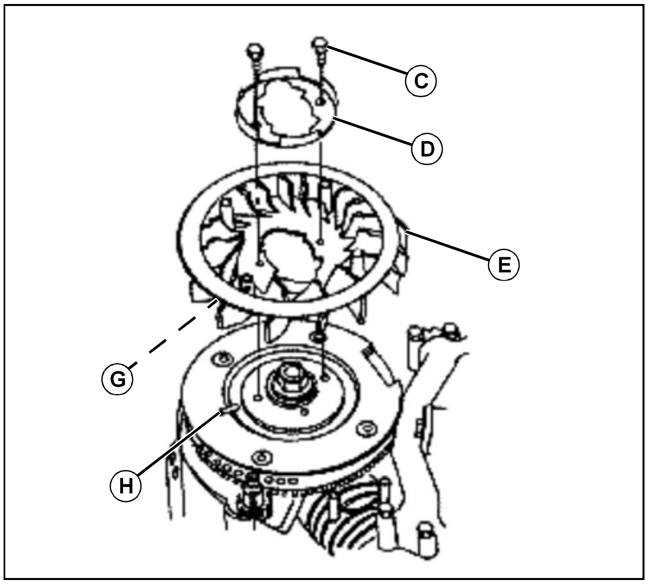
Procedure:

1. Remove rotating screen.
2. Remove blower housing.



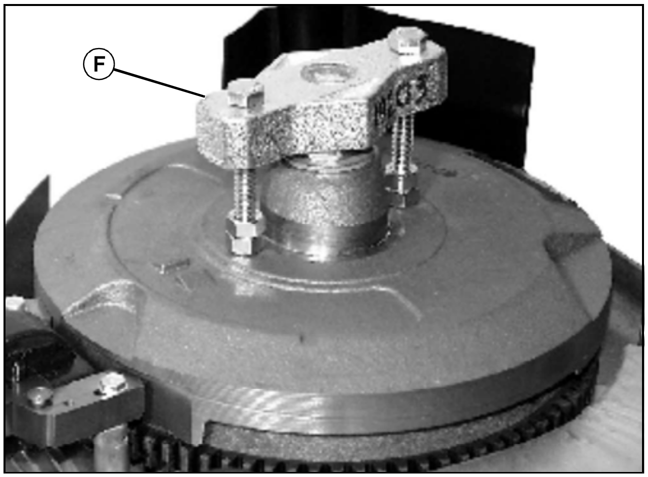
M89926

3. Place flywheel holder (A) on fan retainer with lugs of flywheel holder engaging slots on fan retainer. While flywheel holder, loosen flywheel nut using 30 mm (B) socket and wrench.



MX9624

4. Remove two screws (C), fan retainer (D) and fan (E).



MX9625

5. Install flywheel puller (F) turning puller screws into flywheel puller holes evenly. Tighten puller screws equally until flywheel loosens.

IMPORTANT: Avoid damage! Protect crankcase threads during flywheel removal.

6. Remove flywheel.

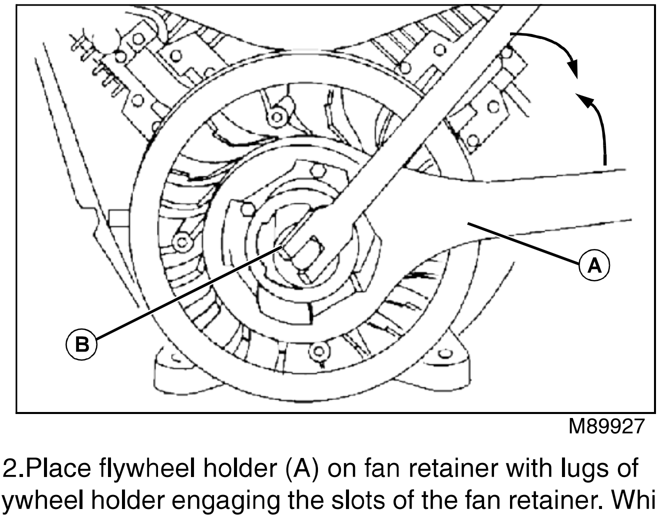
7. Flywheel should be inspected for cracks, broken flywheel fins, burrs on taper or keyway and distortion of keyway. Also check taper of crankshaft for burrs, rust or other damage. Replace crankshaft, if damaged.

8. Before installing flywheel, clean taper and crankshaft taper removing all oil, dirt or grease.

9. Install flywheel.

10. Align boss (G) on back of fan (E) with notch (H) in flywheel.

11. Install flywheel nut.

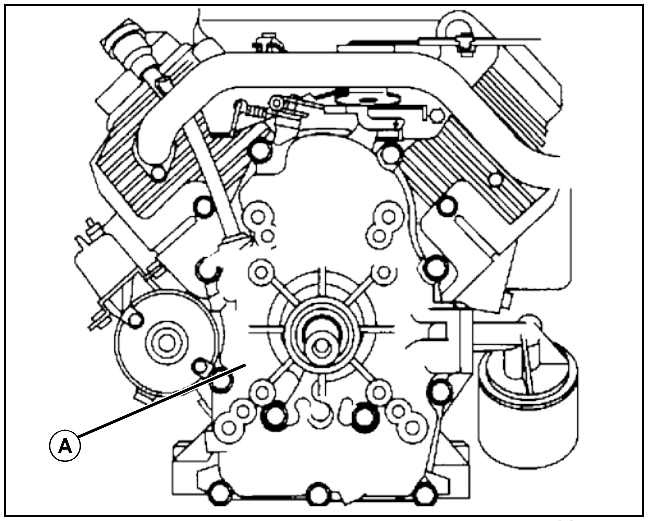


M89927

12. Place flywheel holder (A) on fan retainer with lugs of flywheel holder engaging the slots of the fan retainer. While holding flywheel holder, tighten flywheel nut, using 30 mm (B) socket and wrench, to 175 N•m (125 lb-ft).

Crankshaft Removal and Installation

Procedure:



M87035

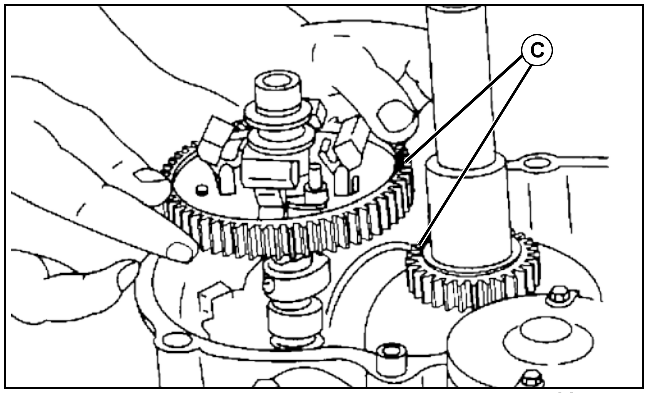
NOTE: Before crankcase cover (A) is removed, it is recommended that any rust, paint or burrs be removed from power take off end of crankshaft. This will eliminate or reduce chances of damaging the crankcase cover bearing.

1. Remove governor lever and disconnect governor link and springs. Remove governor control bracket. Remove oil fill tube and dipstick assembly.

2. Remove exhaust manifold, intake manifold and cylinder heads.

3. Remove crankcase cover. If crankcase cover sticks, tap lightly with soft hammer on alternate sides near dowel pins (B).

IMPORTANT: Avoid damage! DO NOT remove dowel pins.



M88934

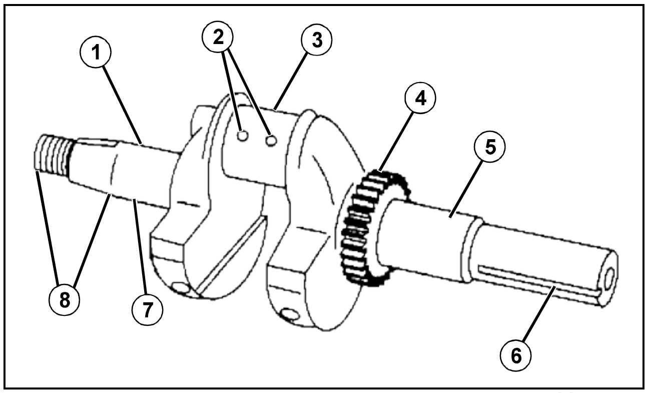
4. Tip engine onto flywheel side of crankcase.

5. Support engine to prevent end of crankshaft from resting on workbench.

6. Rotate crankshaft until timing marks (C) are aligned. With cam gear in this position the valve tappets will remain clear of cam lobes.

IMPORTANT: Avoid damage! If engine is rotated from this position, tappets will fall out. Tappets must not be mixed.

7. Lift out cam gear and governor assembly.



M88935

1. Mag. Journal	5. PTO Journal
2. Oil Galleries	6. Keyway
3. Crankpin	7. Oil Galleries
4. Timing Gear Teeth	8. Threads and Keyway

8. Mark the connecting rods and caps to prevent interchanging when reassembling.

9. Remove piston and connecting rod assemblies.

10.Remove crankshaft from crankcase.

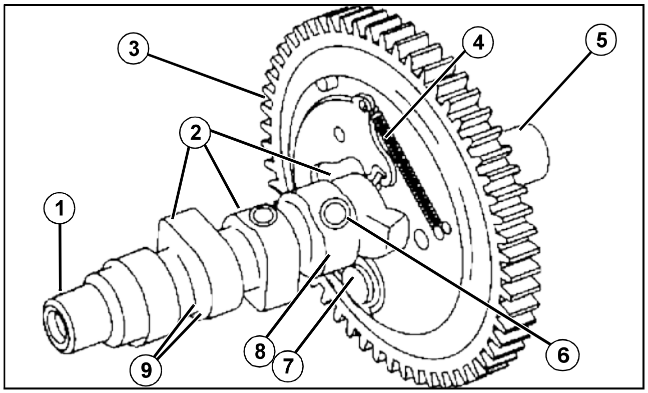
Specifications

Wear Limit Sizes

PTO Journal	**34.92 mm (1.375 in.)**
Mag. Journal	**34.95 mm (1.376 in.)**
Crankshaft Crank Pin	**37.12 mm (1.461 in.)**

IMPORTANT: Avoid damage! All wear points on the crankshaft must be measured.

11.Replace crankshaft if worn or if journals are scored. Keyways should be checked to be sure they are not worn or spread. Remove burrs from keyway edges to prevent damaging the bearing or oil seal. Check oil galleries for blockage or obstructions.



M88937

1. Mag. Journal	6. Compression Release Balls
2. Cam Lobes	7. Flywheel Pivot
3. Gear Teeth	8. Exhaust Lobe
4. Spring	9. Intake Lobe
5. PTO Journal	

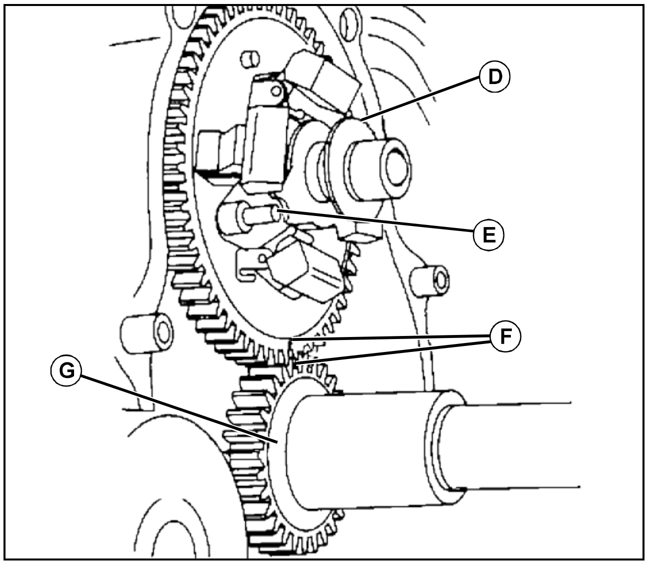
12.Check timing gear for chipped or cracked teeth. Replace if needed.

13.The compression release balls must be clean and free to move when the centrifugal weight is rotated counterclockwise. When the centrifugal weight is released, the balls should move up into the locked position.

14.Inspect cam gear teeth, lobes and journals for wear and nicks. Cam gear journal and lobe reject sizes are as follows:

Specifications

PTO Journal	**19.92 mm (0.784 in.)**
Mag Journal	**15.93 mm (0.627 in.)**
Cam Lobe	**30.25 mm (1.191 in.)**

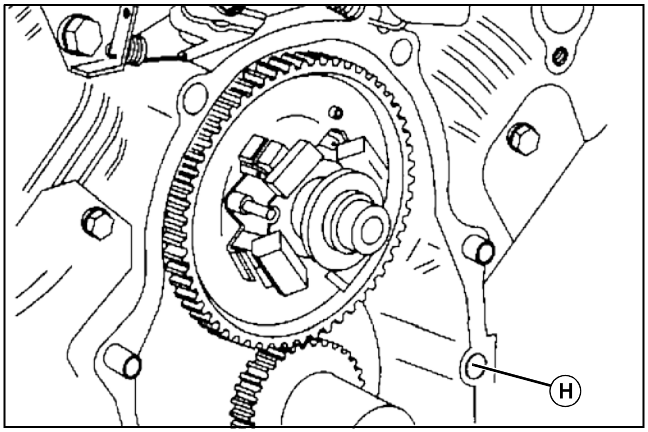


M88938

15.Governor slider (D) must move freely on PTO journal of cam gear. Flywheel must pivot freely. Make sure flyweight spring is not stretched. Governor weights must move freely on hinge pins. Make sure hinge pins are not loose.

16.Assemble governor slider onto PTO journal on cam gear making sure that slot on slider fits over locating pin (E) on cam gear. Be sure the weights are in the proper location so that they will be able to move freely without binding.

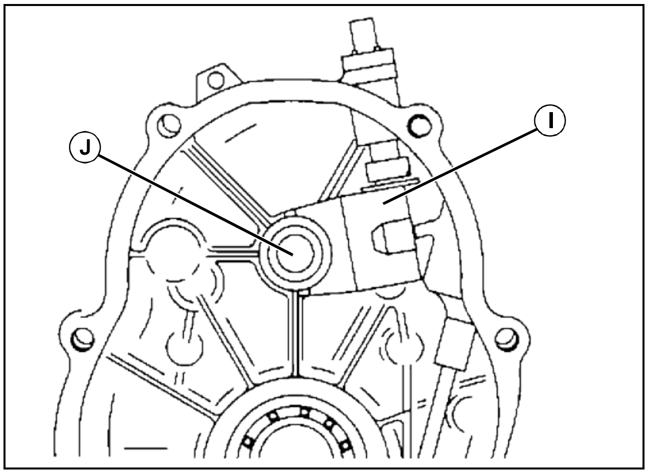
17.Install crankshaft and camshaft, aligning timing marks (F) accordingly. Install thrust washer (G), if required. Tip engine to position crankshaft horizontally.



M88939

18.Place new crankcase cover gasket on crankcase.

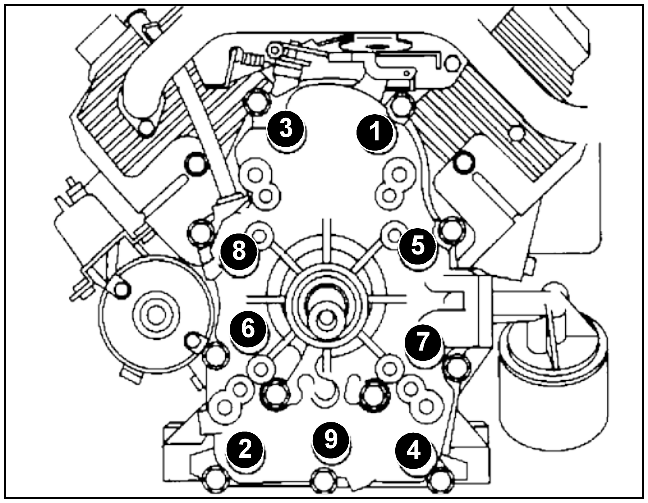
NOTE: Be sure O-ring (H) is installed in crankcase.



M88940

19.Rotate governor shaft (I) against boss (J).

20.Take care to protect the oil seal while assembling crankcase cover. No force should be used.



M88941

21.Tighten cover bolts to 17 N•m (150 lb-in.) in the sequence shown above.

22.Install cylinder heads.

23.Install flywheel.

24.Install intake manifold and carburetor assembly.

25.Install governor lever and governor springs.

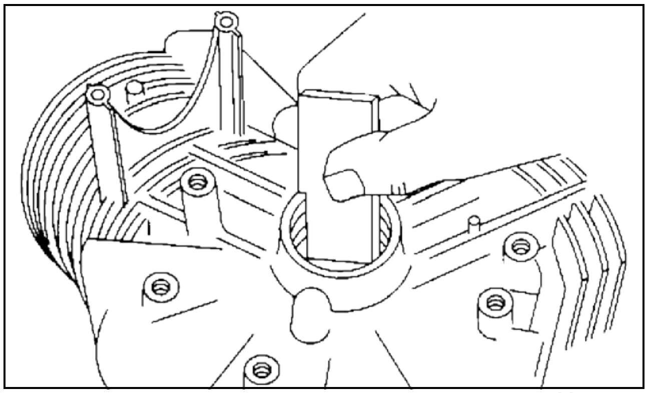
26.Install oil fill tube and dipstick assembly. Perform static governor adjustment.

27.Install engine shrouding.

28.Install air filter assembly.

Magneto Bearing Inspection

Procedure:

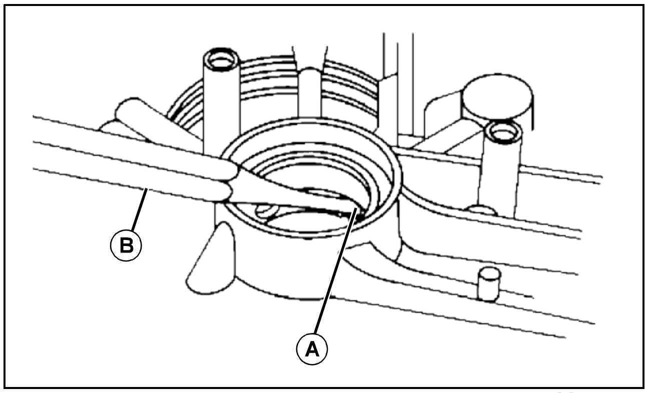


M88943

1. Check the main magneto bearing as shown. Replace if scored or if not within tolerance.

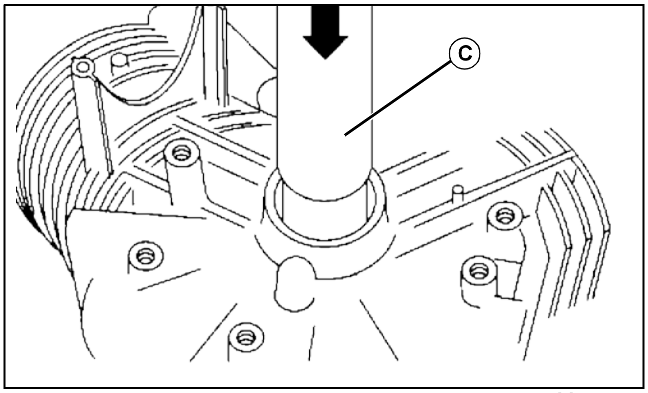
Specifications

Mag Bearing
Reject Size (ID) . . . . 35.12 mm (1.383 in.)



M88944

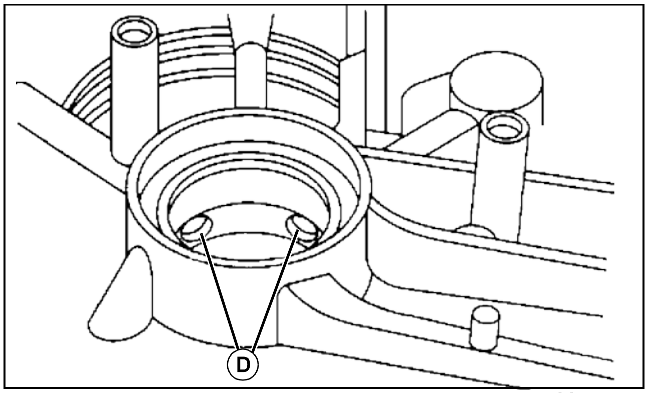
2. To remove the magneto bearing, first remove oil seal. The magneto bearing has a roll pin (A) installed in the oil gallery to prevent the bearing from turning. Use a 4.8 mm (3/16 in.) punch (B) to drive roll pin into oil gallery.



M88945

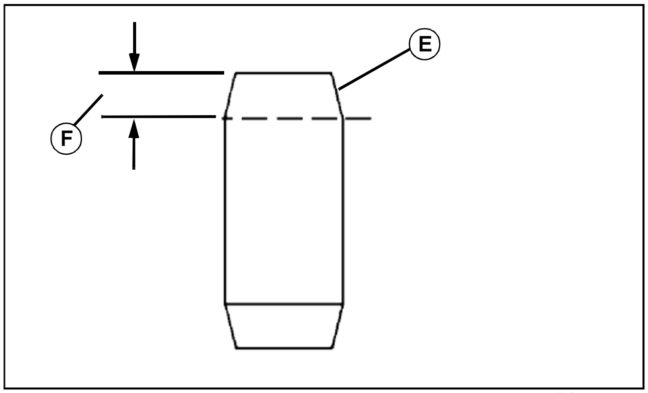
3. To remove magneto bearing, place cylinder on a suitable cylinder support. Press out old bushing with a suitable bushing driver tool (C).

4. To install magneto bearing, place cylinder on a suitable cylinder support. Position new bushing against counterbore bearing in crankcase and carefully align oil holes in bushing with oil gallery holes in bearing. Press in new bushing with a suitable bushing driver tool.



M88946

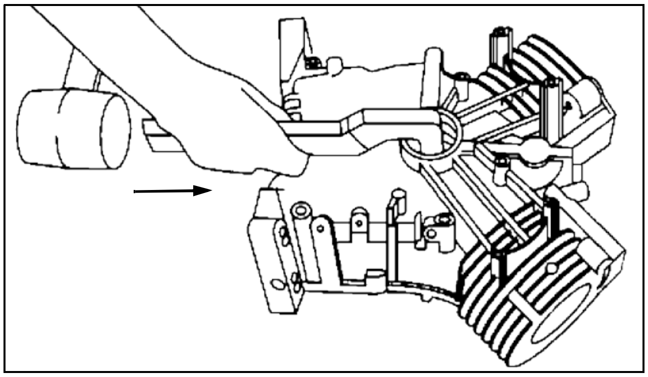
NOTE: Be sure oil holes in bushing are aligned (D) with oil gallery holes in bearing.



M88947

5. Before installing the new roll pin, grind off the taper (E), approximately 3 mm (1/8 in.) (F) from one end of new roll pin. Quench pin in water periodically to prevent loss of temper. Remove all burrs and clean thoroughly.

NOTE: The old roll pin was driven into an oil gallery hole. Place the new roll pin into a second oil gallery hole. Do not use same gallery as the original pin.



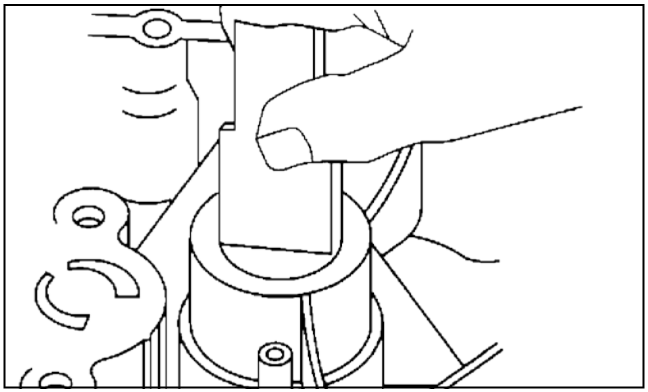
M88948

6. Place tapered end of new roll pin in oil hole in bearing. Use roll pin driver, to install new roll pin. Drive in new roll pin until tool bottoms.

7. Install new oil seal using a suitable cylinder support. Press in new oil seal until it is flush with cylinder.

PTO and Cam Bearing Inspection

Procedure:



M88950

1. Remove oil pump.
2. Remove oil seal.
3. Inspect PTO bearing and cam bearing. The crankcase cover must be replaced if PTO bearing or cam bearing is scored or if dimensions exceed reject size.
4. Install new PTO oil seal using a cylinder support. Press in seal until it is flush with mounting surface.

Specifications:

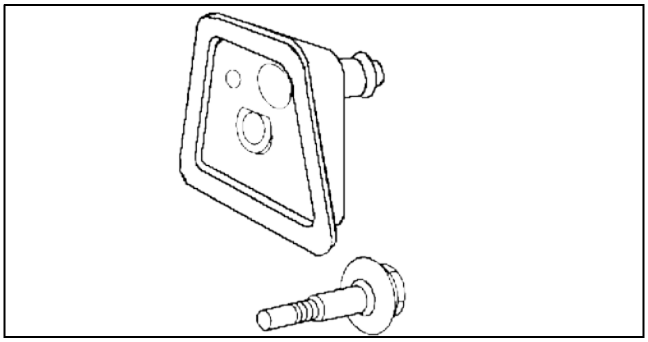
PTO End Bearing Reject Size . . . . 35.07 mm (1.381 in.)

Cam Bearing Reject Size . . . . 20.04 mm (0.789 in.)

NOTE: Always install new oil seal whenever engine is disassembled for major servicing or when repairing bearings. Always use the correct seal protector to prevent damaging oil seal.

Lubrication

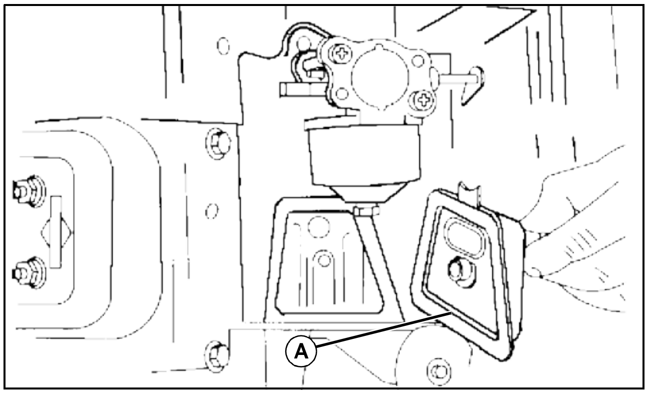
Breather Valve Service



M88912

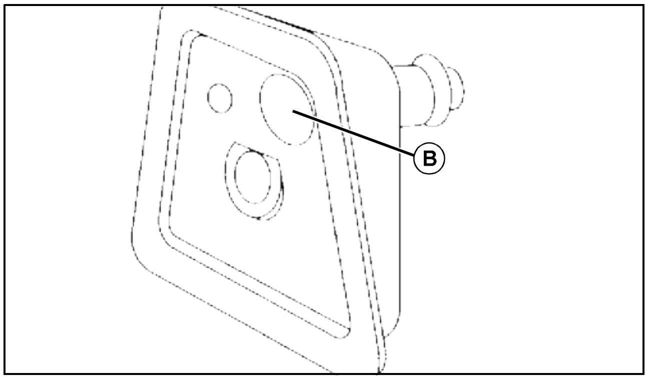
NOTE: A leak at the seal between the tube and crankcase cover, or at the seal at the upper end of the dipstick, can result in a loss of crankcase vacuum and a discharge of oil or smoke through the muffler.

1. The engine utilizes a breather valve to control and maintain a vacuum in the crankcase. The breather valve closes on the up stroke of the piston and opens on the down stroke of the piston to maintain a vacuum in the crankcase. This vacuum prevents oil leakage past piston rings, valve guides, oil seals, governor shaft and gaskets.



M88913

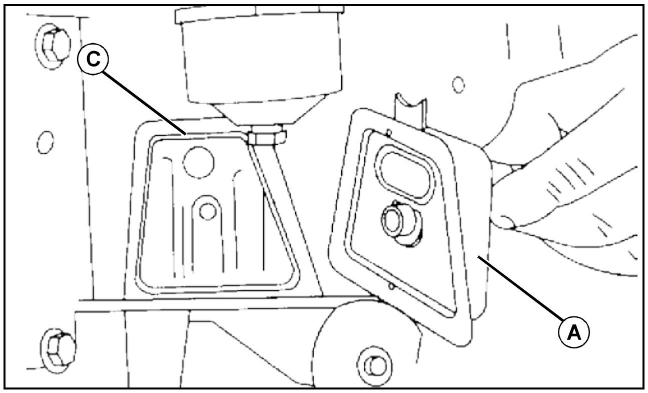
2. Before breather valve assembly (A) can be removed for inspection, the air cleaner assembly and support bracket must be removed.



M88914

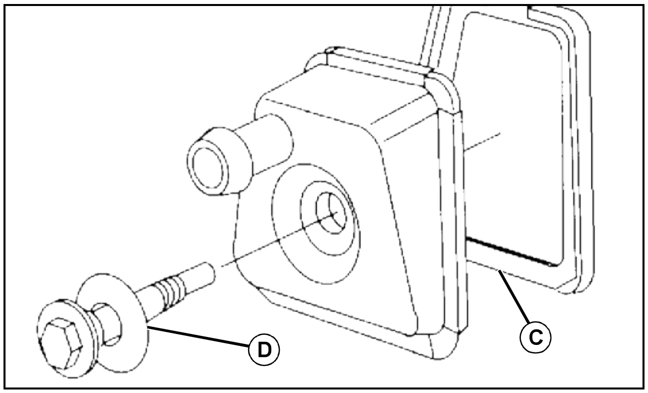
3. The reed valve (B) is spring loaded and must make a complete seal around the vent hole in breather body. Check to see that reed valve is not deformed.

IMPORTANT: Avoid damage! Do not use force on reed valve (B).



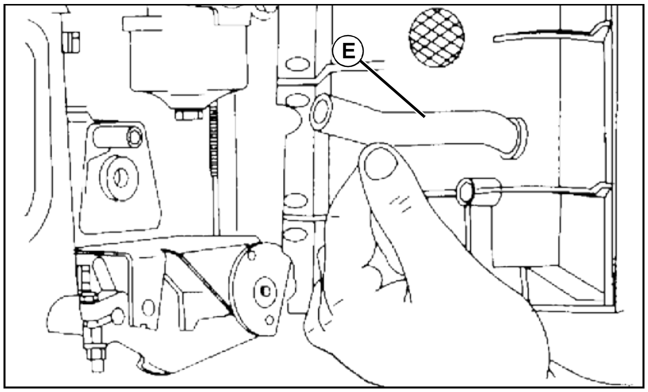
M88915

4. When installing breather valve assembly (A), make sure breather gasket (C) is located properly.



M88916

5. Place breather on gasket (C). Slip large O-ring (D) onto mounting screw and install screw and tighten to 3 N•m (30 lb-in.).

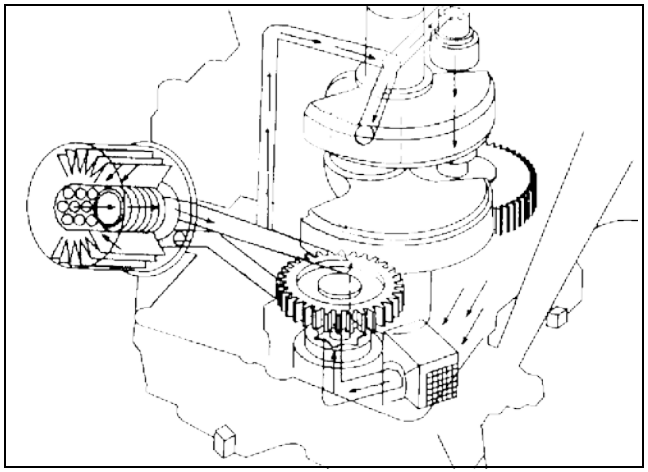


M88917

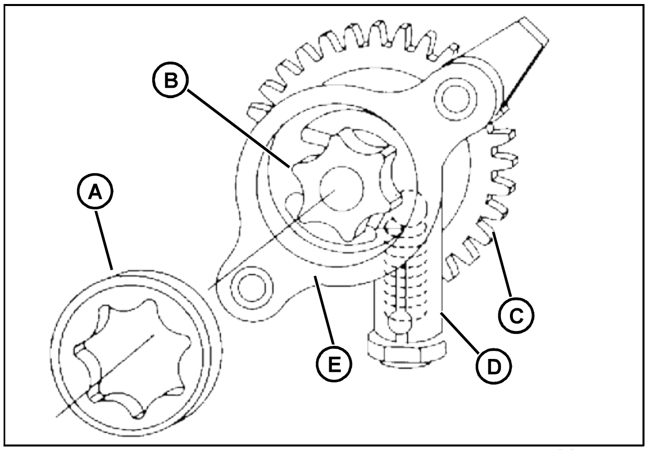
6. The breather is vented through the air cleaner to prevent dirt from entering the crankcase. Check breather tube (E) for cracks, holes or hardening. Replace if damaged.

Oil Pump Removal

This engine is equipped with a full pressure lubrication system with an oil filter.



M88919



M88918

A - Outer Rotor
B - Inner Rotor
C - Drive Gear
D - Pressure Relief Valve
E - Pump Housing

The gear driven oil pump supplies lubrication to all bearing journals.

Specifications:

Oil Pressure . . . . 10 - 50 psi

NOTE: Engine oil pressure will vary with oil viscosity, ambient air temperature differences, operating temperatures and engine load.

The oil pump draws oil through a screened pick up in the engine base and pumps the oil through the oil filter. The filtered oil flows through oil galleries (passages) in the crankcase cover and cylinder where it is distributed to the main bearings and cam gear bearings.

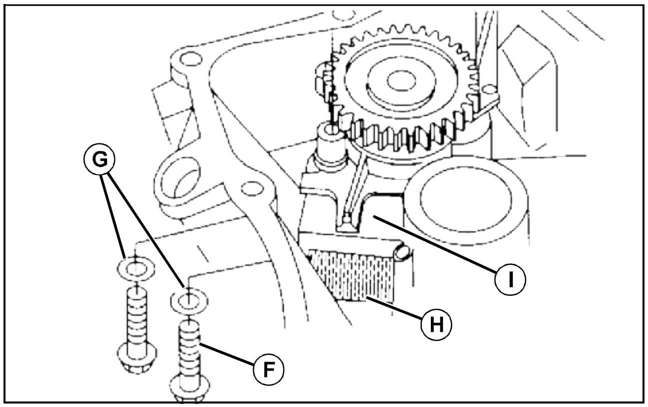
A pressure relief valve located in the oil pump housing limits the maximum oil pressure in the system.

An oil gallery in the crankshaft supplies oil from the magneto bearing to the crankpin, lubricating the connecting rods.

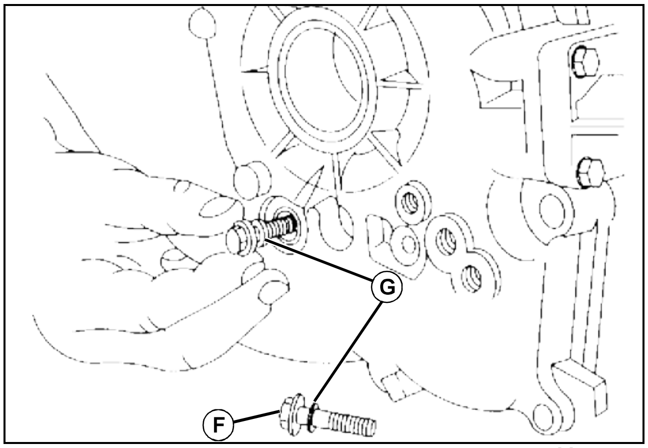
The oil pump is attached to the inside of the crankcase cover.

Procedure:

1. Remove oil fill dipstick assembly.
2. Remove crankcase cover.



M88921



M88920

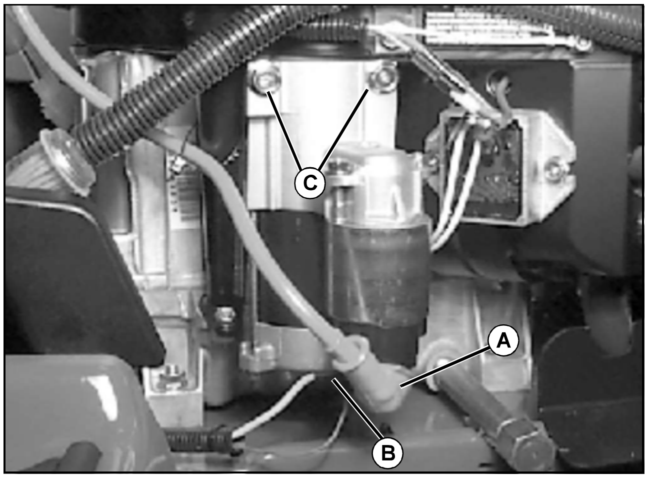
3. Remove two screws (F) and O-Rings (G) attaching oil pump assembly to crankcase cover.
4. The outer rotor of pump can be removed for inspection and cleaning. With pump removed, oil intake screen may be removed for cleaning.
5. Slip oil intake screen (H) into slots in crankcase cover.
6. Install oil pump. Tighten screws (F) to 7 N•m (65 lb-in.).

NOTE: Boss (I) on oil pump body holds intake screen in proper position. Be sure to install new "O" rings (G) on pump mounting screws (F).

Starting Motor Removal and Installation

Removal:

1. Disconnect the negative (-) battery cable from the battery.



M95074

2. Disconnect battery positive (+) cable (A) from starting motor.
3. Disconnect wires (B) from the starting motor.
4. Remove starting motor bolts (C) and starting motor.

Installation:

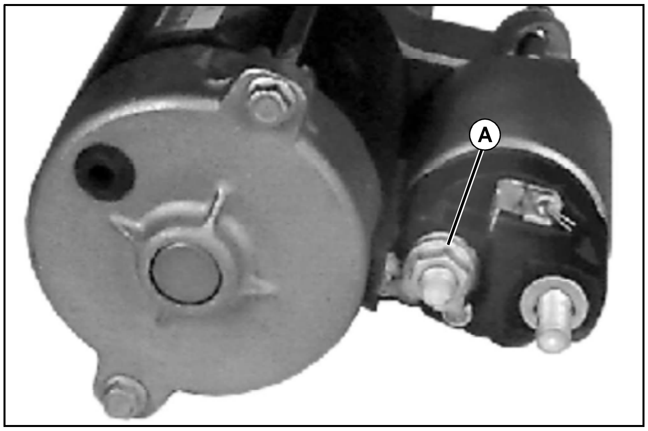
1. Install starting motor bolts and tighten to 15.8 N•m (140 lb-in.).
2. Connect electrical wires and battery cable.
3. Connect the negative (-) battery cable to the battery.

Starting Motor Disassembly and Inspection

Special or Essential Tools:

- Multimeter or ohm meter

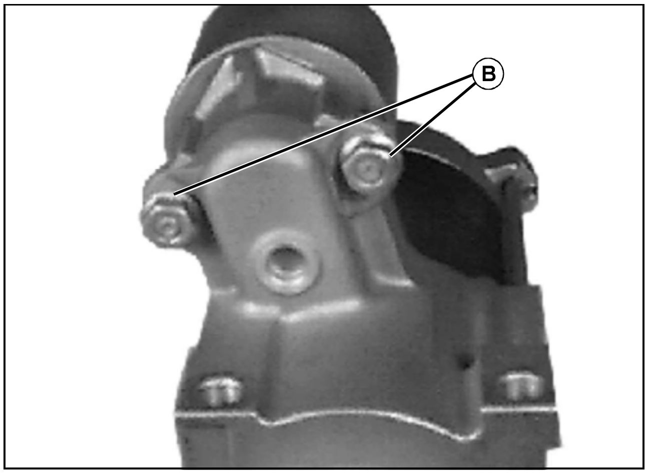
Procedure:



M95075

1. Remove nut (A) securing braided copper wire to solenoid.

2. Slide wire off of solenoid lug.

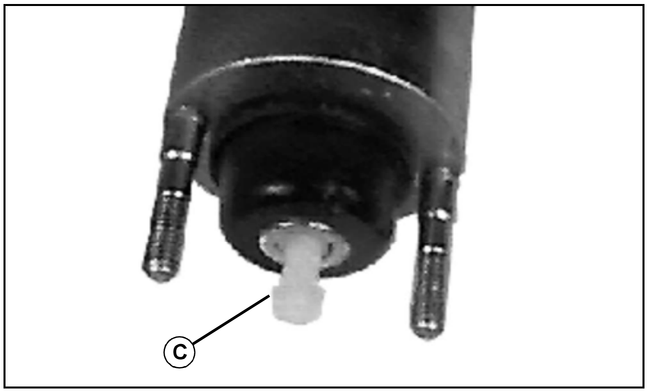


M95076

3. Remove nuts (B) from solenoid mounting bolts.

NOTE: Solenoid plunger is hooked over solenoid shift lever in starting motor housing.

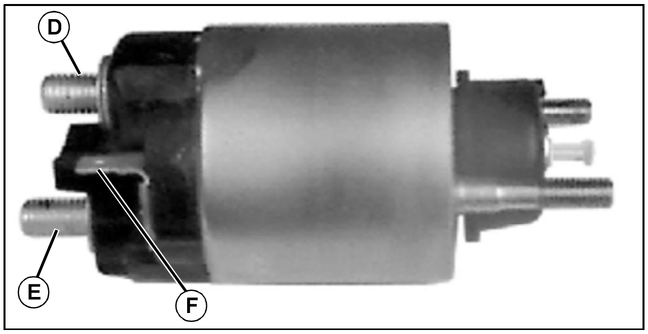
4. Slide solenoid out of staring motor housing and lift away from starting motor housing to remove plunger (C) from shift lever.



M95078

5. Inspect plunger (C) for wear or damage. Press plunger into solenoid to check spring compression and freedom of movement.

6. If the solenoid plunger is broken, does not move freely, or there is little or no spring tension, replace the solenoid.

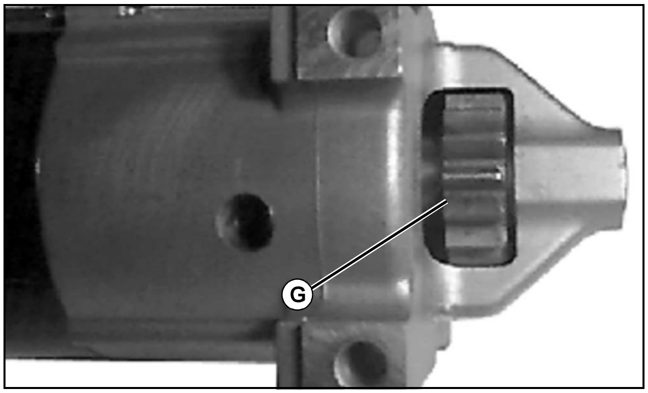


M95077

7. Using a multimeter or ohm meter, check the following for correct resistance:

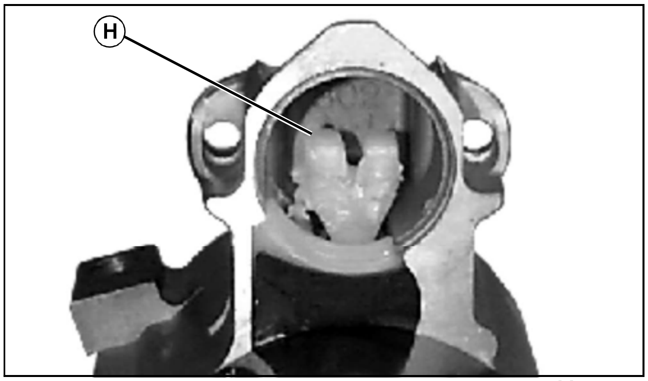
D to E	**No Continuity**
E to F	**No Continuity**
D to F	**Less than 1 ohm**
D and F to solenoid housing	**1 to 2 ohms**

8. If the resistance measured is not correct, replace the solenoid.



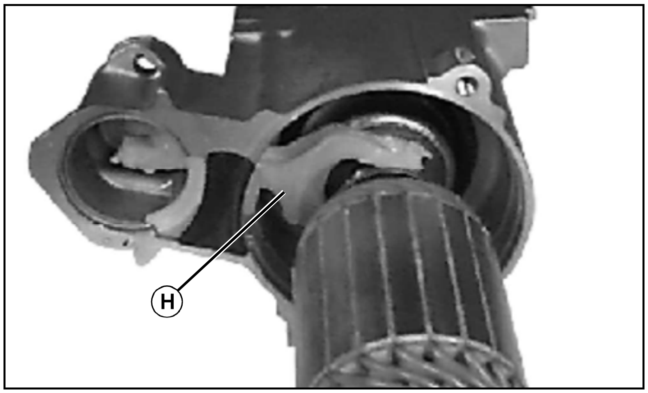
M95083

9. Inspect starting motor pinion gear (G). The pinion gear should rotate and slide on the armature shaft smoothly.



M95084

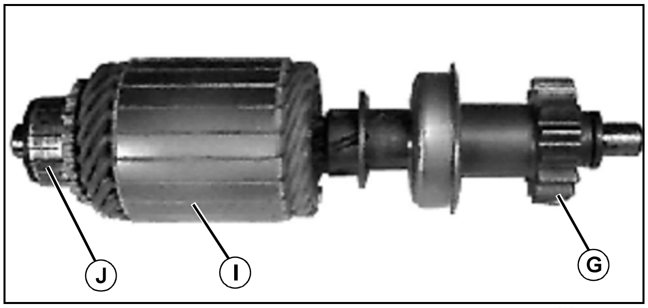
10.Inspect the shift lever (H) for damage. Ensure that shift lever operates pinion gear. If the shift lever is damaged or does not move the pinion gear in and out of starting motor, replace the lever.



M95079

11.Remove the two bolts securing the starting motor housing halves together. Slide the armature housing off of the starting motor.

12.Remove the shift lever and pivot.



M95080

13.Remove the armature assembly (I) from starting motor housing.

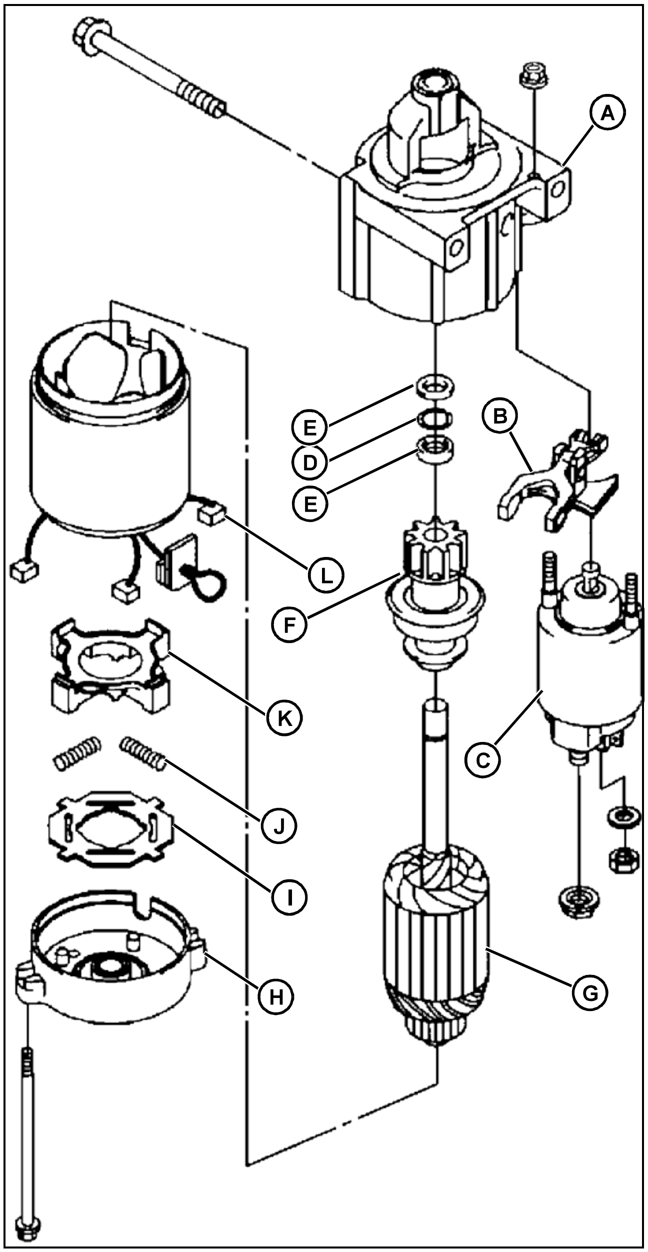
IMPORTANT: Avoid damage! DO NOT use emery cloth to clean the commutator (J). The particles from the cloth will become embedded in the commutator and cause rapid brush wear.

NOTE: The armature should not be soaked in a cleaning solution.
Fine sandpaper, such as crocus cloth, can be used to clean the armature.

14.Check the brushes should for proper seating, weak brush springs, dirt, oil or corrosion.

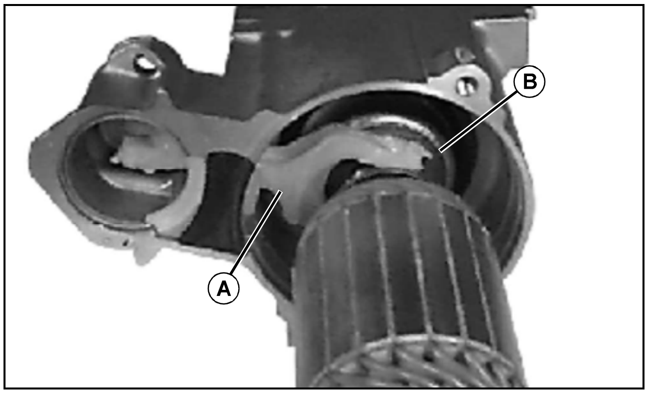
15.When all parts have been thoroughly cleaned, lightly lubricate the bearings with #20 oil.

Starting Motor Assembly



M94902

A - Front Cover
B - Shift Lever
C - Solenoid
D - Pinion Stopper
E - Retaining Clip
F - Pinion
G - Armature
H - End Cover
I - Insulator
J - Brush Holder
K - Brush Springs
L - Brush



M95079

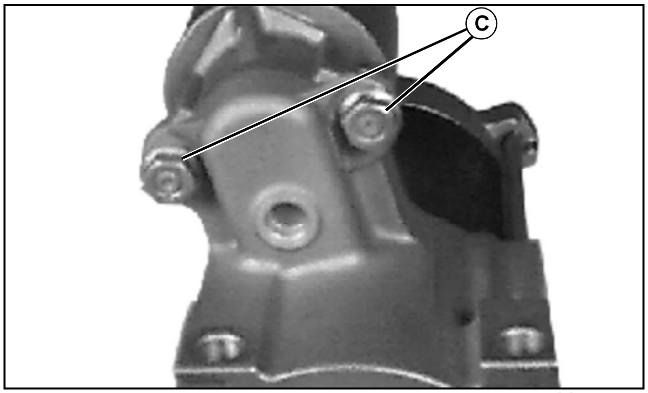
1. Place armature in housing end.

2. Install shift lever (A). Ensure shift lever fork is seated in pinion gear shift collar (B).

3. Install armature housing, brush housing and end cap over armature. Secure with two long cap screws.

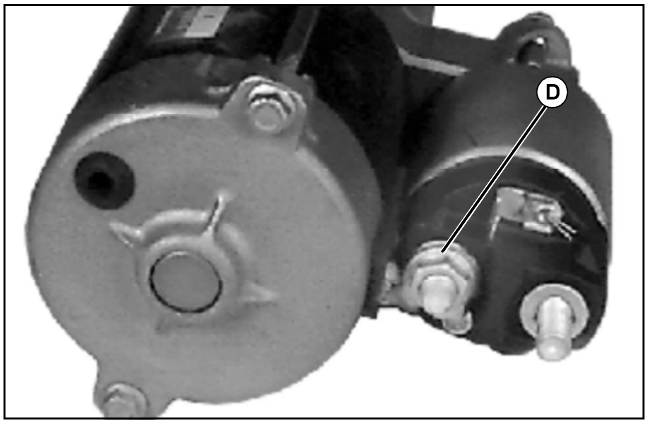
4. Liberally lubricate shift lever (A) with grease.

5. Install solenoid to starting motor. Ensure solenoid plunger seats over shift lever fork.



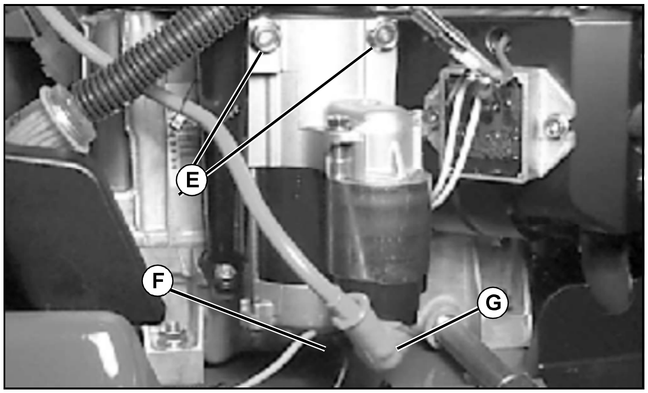
M95076

6. Secure solenoid with two nuts (C).



M95075

7. Carefully slide braided copper wire over solenoid lug. Secure wire to lug with flange nut (D).



M95074

8. Install starting motor drive. Install through bolts (E) in starting motor.

9. Install starting motor. Tighten bolts to 15.8 N•m (140 lb-in.).

10.Connect wires (F) to starting motor. Connect battery cable (G) to starting motor.

11.Connect negative (-) battery cable to battery.

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General Information

Operation and Diagnostics

The operation and diagnostics stories divide the electrical system into individual circuits by function. Each circuit is isolated from the main wiring schematic and only shows the components that are used in it. The story contains information on function, operating conditions, and theory of operation. The circuit schematic s are drawn with the components in the operating position, with the power, or battery positive, into them across the top and the ground, or battery negative, across the bottom.

Diagnostic Information

The diagnostic procedures is used to test the complete circuit regardless of the problem or complaint. Select a symptom or system from the quick check or troubleshooting chart and follow the test procedures under that heading.

The diagnostic procedure lists:

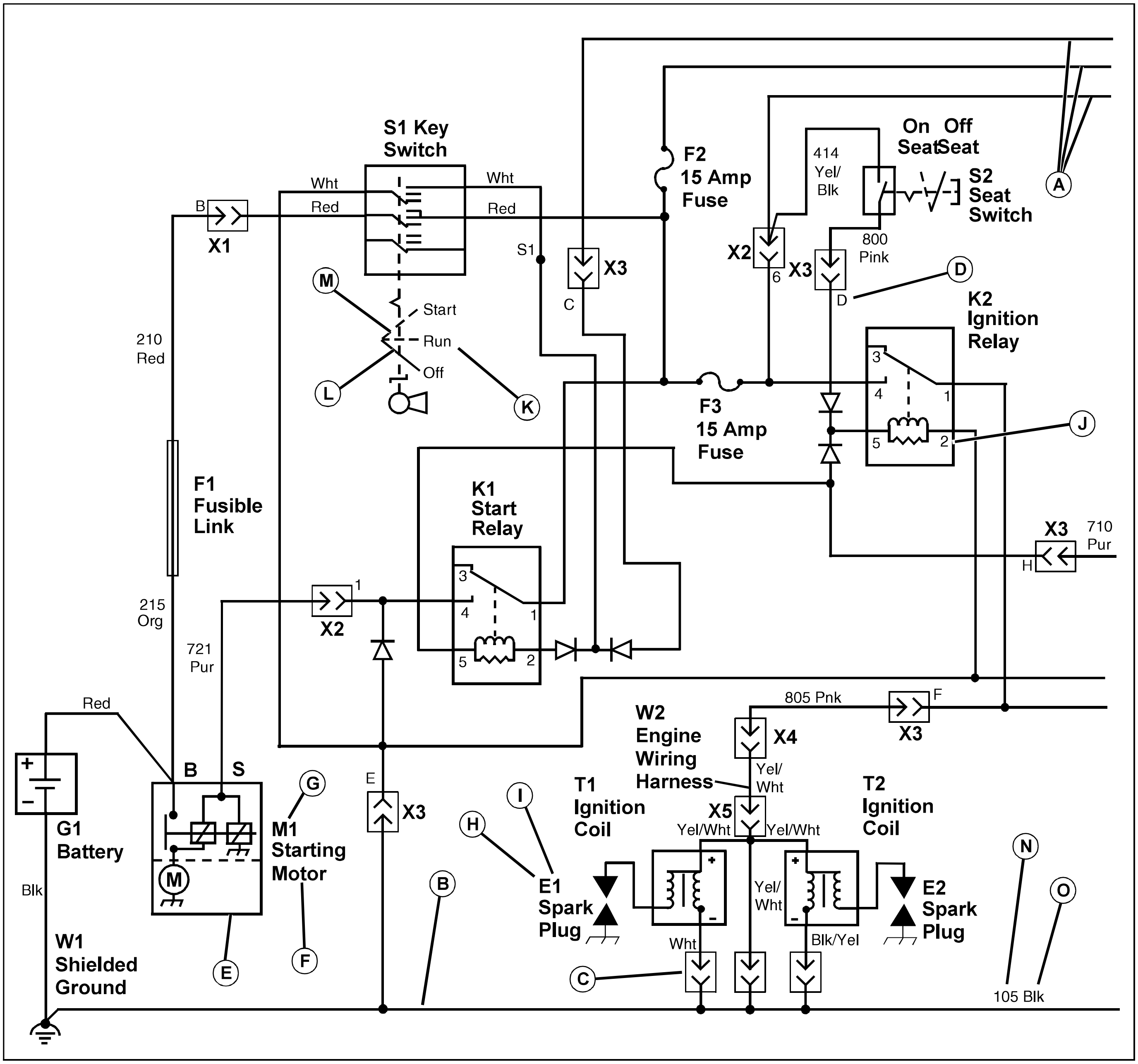
- Test conditions
- Test sequence
- Test location
- Normal reading
- Check or test to perform if reading is not normal

When performing the test or check, be sure to set your machine up to the test conditions listed and follow the sequence carefully. performing the test or check. If the results of the test or check are not normal, perform the test, The diagram that accompanies each test procedure is drawn to resemble machine components. The key letter on the art matches the letter in the procedure and the leader line points to the exact point the test is to be made.

Wire Color Abbreviation Chart

Blk	**Black**
Blu	**Blue**
Brn	**Brown**
Grn	**Green**
Gry	**Gray**
Org	**Orange**
Pnk	**Pink**
Pur	**Purple**
Red	**Red**
Tan	**Tan**
Wht	**White**
Yel	**Yellow**
Lt Blue	**Light Blue**
Lt Grn	**Light Green**
Org/Wht	**Orange/White**

Reading Electrical Schematics


S1 Key
Switch
Wht
Red
Wht
Red
B
X1
S1
X3
C
F2
15 Amp
Fuse
414
Yel/
Blk
On Off
Seat Seat
S2
Seat
Switch
A
X2
6
X3
D
800
Pink
D
K2
Ignition
Relay
M
Start
Run
Off
L
K
210
Red
3
4
1
5
2
J
F3
15 Amp
Fuse
F1
Fusible
Link
K1
Start
Relay
X3
710
Pur
H
215
Org
721
Pur
1
X2
3
4
1
5
2
Red
805 Pnk
F
X3
W2
Engine
Wiring
Harness
X4
Yel/
Wht
B
S
G
M1
Starting
Motor
E
X3
I
H
T1
Ignition
Coil
X5
Yel/Wht
Yel/Wht
T2
Ignition
Coil
N
G1
Battery
Blk
M
B
E1
Spark
Plug
Yel/
Wht
E2
Spark
Plug
O
W1
Shielded
Ground
E
F
Wht
Blk/Yel
C
105 Blk

mif

The schematic is made up of individual circuits laid out in a sequence of related functions. It is formatted with all power wires (A) across the top and all ground wires (B) across the bottom. Current flow is generally from top to bottom through each circuit and component. All components are shown in the off position. The diagram does not list connector (C) information unless needed to avoid confusion. If the connector is shown, the number next to it is the terminal pin location (D) in the connector.

Each component is shown by a symbol (E), its name (F), and an identification code (G). The identification code contains a device identifying letter (H) and number (I).

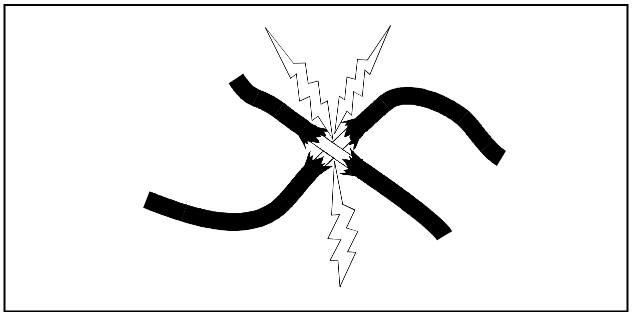
The identifying letter is always the same for a specific component, but the identifying numbers are numbered consecutively from upper left to lower right. The terminal designation (J) is placed directly inside or outside the symbol next to the connecting wire path. Switch positions (K) are also placed directly inside or outside the symbol. The solid line (L) shows the position the switch is currently in and dash lines (M) represent other switch positions.

The circuit number (N) and wire color (O) of the wires are shown directly next to the wire path.

The same component name and identification code are used consistently on all diagrams in this section. Components can be easily cross-referenced.

Common Circuit Tests

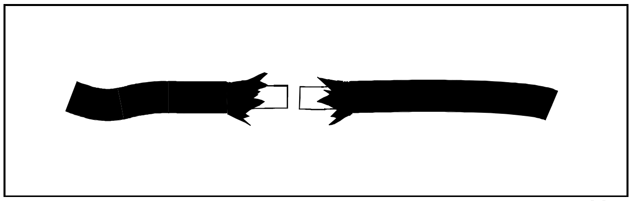
Shorted Circuit:



A shorted circuit may result in the wrong component operating (i.e. improper wire-to-wire contact). To test for a shorted or improperly wired circuit:

1. Turn component switch on.
2. Start at the controlling switch of the component that should not be operating.
3. Follow the circuit and disconnect wires at connectors until component stops operating.
4. Shorted or improper connections will be the last two wires disconnected.

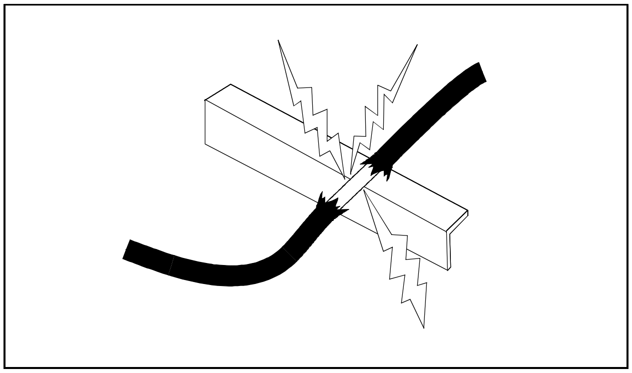
High Resistance or Open Circuit:



High resistance or open circuits usually result in slow, dim or no component operation (i.e. poor, corroded, or disconnected connections). Voltage at the component will be low when the component is in operation. To test for high resistance and open circuits:

1. Check all terminals and grounds of the circuit for corrosion.
2. If terminals are not corroded or loose, the problem is in the component or wiring.

Grounded Circuit:



Grounded circuits usually result in no component operation or a blown fuse.

Conductors for 12 Volt Circuits

Stranded Conductors For 12 Volt Circuits						
SAE WIRE SIZE (GAUGE)	20	18	16	14	12	10
METRIC WIRE SIZE (MM)	0.5	0.8	1.0	2.0	3.0	5.0
TYPICAL STRANDING	7 X 28	16 X 30	19 X 29	19 X 27	19 X 25	19 X 23
MINIMUM CONDUCTOR AREA IN CIRCULAR MILS	1072	1537	2336	3702	5833	9343

ELECTRICAL SPECIFICATIONS

Specifications

General Specifications

Battery:

Voltage	**12 VDC**
BCI group	**51**
Cold Cranking Amps at -18° C (0° F)	**500 amps**
Reserve Capacity at 27° C (80° F)	**85 Minutes**

Spark Plug:

LX255:

Type	**Champion RC12YC**
Gap	**1.0 mm (0.040 in.)**
Torque	**41 N•m (30 lb-ft)**

LX266:

Type	**Champion RC12YC**
Gap	**1.0 mm (0.040 in.)**
Torque	**41 N•m (30 lb-ft)**

LX277:

Type	**Champion RCJ8Y**
Gap	**1.0 mm (0.040 in.)**
Torque	**15 N•m (133 lb-in.)**

LX279:

Type	**NGK BPR2ES**
Gap	**0.7 mm (0.028 in.)**
Torque	**20 N•m (177 lb-in.)**

LX288 (SN - 090000):

Type	**Champion RC12YC**
Gap	**0.75 mm (0.030 in.)**
Torque	**20 N•m (177 lb-in.)**

LX288 (SN090001 -):

Type	**Champion RCJ8Y**
Gap	**0.75 mm (0.030 in.)**
Torque	**22 N•m (195 lb-in.)**

Stator:

LX255 and LX266:

Size	**15 amps**
Regulated Amperage (Minimum) at Fast Idle	**15 amps**
Regulated Voltage (Minimum) at Fast Idle	**12.2 - 14.7 volts DC**
Unregulated Voltage (Minimum) at Fast Idle	**28 volts AC**

ELECTRICAL SPECIFICATIONS

LX277, LX279, and LX288 (SN 090001-):

Size	**15 amps**
Regulated Amperage (Minimum) at Fast Idle	**13 amps**
Regulated Voltage (Minimum) at Fast Idle	**12.2 - 14.7 volts DC**
Unregulated Voltage (Minimum) at Fast Idle	**28 volts AC**

LX288 (SN -090000):

Size	**16 amps**
Regulated Amperage (Minimum) at Fast Idle	**3 - 16 amps**
Regulated Voltage (Minimum) at Fast Idle	**12.2 - 14.7 volts DC**
Unregulated Voltage (Minimum) at Fast Idle	**30 volts AC**

Starting Motor:

Maximum Amperage (Load 85 amps at 500 rpm

Ignition Coil Air Gap:

LX255	**0.25 mm (0.01 in.)**
LX266	**0.25 mm (0.01 in.)**
LX277	**0.25 - 0.40 mm (0.010 - 0.016 in.)**
LX279	**Fixed position, no adjustment**
LX288 (SN - 090000)	**0.20 - 0.30 mm (0.008 - 0.012 in.)**
LX288 (SN 090001 -)	**0.30 mm (0.012 in.)**

Ignition:

LX255

Primary Coil Resistance (One Direction)	**5 - 1000 ohms**
Primary Coil Resistance (Other Direction - Minimum)	**30k ohms**
Secondary Coil Resistance	**7.9 - 10.8k ohms**

LX266:

Primary Coil Resistance (One Direction)	**5 - 1000 ohms**
Primary Coil Resistance (Other Direction - Minimum)	**30k ohms**
Secondary Coil Resistance	**7.9 - 10.8k ohms**

LX277:

Primary Coil Resistance	**9 - 20 ohms**
Secondary Coil Resistance	**8 - 11 ohms**

LX279:

Primary Coil Resistance	**3.4 - 4.6 ohms**
Secondary Coil Resistance	**10.4 - 15.6k ohms**

LX288 (SN -090000):

Primary Coil Resistance	**0.67 - 1.10 ohms**
Secondary Coil Resistance	**6 - 10 ohms**

LX288 (SN 090001-):

Primary Coil Resistance	**9 - 20 ohms**
Secondary Coil Resistance	**8 - 11 ohms**

ELECTRICAL SPECIFICATIONS

Pulser Coil - LX279:

Resistance. . . . . 88 - 132 ohms

Electric PTO Clutch:

Resistance. . . . . 2.4 - 2.7 ohms
Current Draw. . . . . 4 amps

Coolant Temperature Switch - LX279:

Closing Temperature . . . . 111° C (232° F)

Lighting:

Headlights . . . . .1156 or equivalent

Tools

Special or Required Tools

Tool Name	Tool No.	Tool Use
Electronic Control Analyzer	JDG1575	Test and adjust position sensors.
Weatherpack extraction Tool	JDG364	To remove contacts from weatherpack connectors.
Electrical Circuit Analyzer	JT07324A	To diagnose key switch and associated electrical circuits.
Current Clamp-on Probe	JT02153	To diagnose current amperage with in electrical wires.
Analog/Digital Multimeter	JT05791	To diagnose electrical system circuits and components.
Probe Light	JDG186	To test for current continuity and grounds.
Hydrometer	NA	Used to check specific gravity of electrolyte in battery cells.
Battery Tester (or Voltmeter)	JT05685	Used to measure battery voltage.
Current Gun	JT05712	Used to measure alternator output current.
Hand-Held Digital Tachometer	JTO5719	Used to measure speed of starting motor.
Spark Tester	D05351ST	Used to test the spark strength from the ignition module.

Other Materials

Other Material

Part No.	Part Name	Part Use
TY9374/TY9375	Pipe sealant with Teflon®	Seal threads on temperature sensor and oil pressure switches.
NA	Bearing Puller Set	Used to remove pulley from alternator.
NA	400-grit Silicon Carbide Sandpaper	Used to polish slip rings.

NOTE: Teflon is a registered trademark of the Du Pont Company.

Schematics and Wiring Harness Legends

Schematic and Wiring Harness Legend - LX255 and LX266

Components:

A1 - Interlock Module (SE3, W1)

A2 - Discharge (SE7, W2)

B1 - Engine Oil Pressure Switch (SE5, W3)

E1 - Spark Plug (SE2, W3)

E2 - R.H. Headlight (SE7, W7)

E3 - L.H. Headlight (SE7, W7)

F1 - Fusible Link (SE1, W1)

F2 - Fuse 15 amp (SE3, W1)

F3 - Fuse 15 amp (SE3, W1)

G1 - Battery (SE1, W1)

G2 - Stator (SE7, W3)

H1 - Engine Oil Pressure Light (SE5, W1)

H2 - Discharge Light (SE7, W1)

H3 - Coolant Temperature Light Socket (SE4, W1)

M1 - Starting Motor (SE1, W1)

N1 - Voltage Regulator/Rectifier (SE7, W3)

S1 - Key Switch (SE2, W1)

S2 - Seat Switch (SE3, W1)

S3 - RIO Switch (SE3, W1)

S4 - PTO/RIP switch (SE4, W1)

S5 - Brake/Neutral Start Switch (SE5, W1)

S6 - Headlight Switch (SE7, W1)

T1 - Magneto Ignition (SE2, W3)

W1 - Shielded Ground (SE1, W1)

Y1 - PTO Clutch (SE4, W4)

Y2 - Fuel Shutoff Solenoid (SE6, W3)

Connectors:

X1 - W1 Main Wiring Harness to S1 Key Switch (SE1, W1)

X2 - W1 Main Wiring Harness to A1 Interlock Module (SE2, W1; SE3, W1)

X3 - W1 Main Wiring Harness to A1 Interlock Module (SE2, W1; SE3, W1)

X4 - W1 Main Wiring Harness to W2 Engine Wiring Harness (SE2, W1; SE5,W1;SE7,W1)

X5 - W2 Engine Wiring Harness to W3 Engine Wiring Harness (SE2, W2; SE5, W2; SE6, W2; SE7, W2)

X6 - W1 Main Wiring Harness to PTO Clutch (SE4, W1)

X7 - W2 Engine Wiring Harness to Y1 Fuel Shutoff Solenoid (SE5, W3)

X8 - W2 Engine Wiring Harness to A2 Discharge Module (SE7, W2)

X9 - W1 Main Wiring Harness to Headlights (SE7, W1)

Wiring Harnesses:

W1 - Main Wiring Harness

W2 - Engine Wiring Harness

W3 - Engine Wiring Harness

W4 - PTO Clutch Wiring Harness

W5 - Fuel Shutoff Solenoid Ground Wire

W6 - Voltage Regulator/Rectifier Ground Wire

W7 - Headlight Wiring Harness

Schematic and Wiring Harness Legend - LX277

Components:

A1 - Interlock Module (SE3, W1)

B1 - Engine Oil Pressure Switch (SE5, W2)

E1 - Spark Plug (SE2, W3)

E2 - Spark Plug (SE2, W3)

E3 - R.H. Headlight (SE7, W8)

E4 - L.H. Headlight (SE7, W8)

F1 - Fusible Link (SE1, W1)

F2 - Fuse 15 amp (SE3, W1)

F3 - Fuse 15 amp (SE3, W1)

G1 - Battery (SE1, W1)

G2 - Stator (SE7, W7)

H1 - Engine Oil Pressure Light (SE5, W1)

H2 - Discharge Light (SE7, W1)

H3 - Coolant Temperature Light Socket (SE4, W1)

M1 - Starting Motor (SE1, W1)

N1 - Voltage Regulator/Rectifier (SE7, W2)

S1 - Key Switch (SE2, W1)

S2 - Seat Switch (SE3, W1)

S3 - RIO Switch (SE3, W1)

S4 - PTO/RIP switch (SE4, W1)

S5 - Brake/Neutral Start Switch (SE6, W1)

S6 - Headlight Switch (SE7, W1)

T1 - Magneto Ignition (SE2, W3)

T2 - Magneto Ignition (SE2, W3)

W1 - Shielded Ground (SE1, W1)

Y1 - PTO Clutch (SE4, W4)

Y2 - Fuel Shutoff Solenoid (SE6, W5)

Connectors:

X1 - W1 Main Wiring Harness to S1 Key Switch (SE1, W1)

X2 - W1 Main Wiring Harness to A1 Interlock Module (SE2, W1; SE3, W1)

X3 - W1 Main Wiring Harness to A1 Interlock Module (SE2, W1; SE3, W1)

X4 - W1 Main Wiring Harness to W2 Engine Wiring Harness (SE2, W1; SE5,W1;SE6,W1;SE7,W1)

X5 - W2 Engine Wiring Harness to W3 Engine Wiring Harness (SE2, W2)

X6 - W1 Main Wiring Harness to PTO Clutch (SE4, W1)

X7 - W2 Engine Wiring Harness to Y1 Fuel Shutoff Solenoid (SE5, W2)

X8 - W1 Main Wiring Harness to Headlights (SE7, W1)

Wiring Harnesses:

W1 - Main Wiring Harness

W2 - Engine Wiring Harness

W3 - Engine Wiring Harness

W4 - PTO Clutch Wiring Harness

W5 - Fuel Shutoff Solenoid Power Wiring Harness

W6 - Fuel Shutoff Solenoid Ground Wire Harness

W7 - Stator Wiring Harness

W8 - Headlight Wiring Harness

Schematic and Wiring Harness Legend - LX279

Components:

A1 - Interlock Module (SE3, W1)

A2 - Ignition Module (SE2, W2; SE2, W4)

B1 - Pulser Coil Left (SE2, W4)

B2 - Pulser Coil Right (SE2, W4)

B3 - Coolant Temperature Switch (SE4, W7)

B4 - Engine Oil Pressure Switch (SE5, W7)

E1 - Spark Plug (SE2, W2)

E2 - Spark Plug (SE2, W2)

E3 - R.H. Headlight (SE7, W11)

E4 - L.H. Headlight (SE7, W11)

F1 - Fusible Link (SE1, W1)

F2 - Fuse 15 amp (SE3, W1)

F3 - Fuse 15 amp (SE3, W1)

G1 - Battery (SE1, W1)

G2 - Stator (SE7, W10)

H1 - Engine Oil Pressure Light (SE5, W1)

H2 - Discharge Light (SE7, W1)

H3 - Coolant Temperature Light (SE4, W1)

M1 - Starting Motor (SE1, W1)

N1 - Voltage Regulator/Rectifier (SE7, W6)

S1 - Key Switch (SE2, W1)

S2 - Seat Switch (SE3, W1)

S3 - RIO Switch (SE3, W1)

S4 - PTO/RIP switch (SE4, W1)

S5 - Brake/Neutral Start Switch (SE6, W1)

S6 - Headlight Switch (SE7, W1)

T1 - Magneto Ignition (SE2, W2)

T2 - Magneto Ignition (SE2, W2)

W1 - Shielded Ground (SE1, W1)

Y1 - PTO Clutch (SE4, W5)

Y2 - Fuel Shutoff Solenoid (SE6, W8)

Connectors:

X1 - W1 Main Wiring Harness to S1 Key Switch (SE1, W1)

X2 - W1 Main Wiring Harness to A1 Interlock Module (SE2, W1; SE3, W1)

X3 - W1 Main Wiring Harness to A1 Interlock Module (SE2, W1; SE3, W1)

X4 - W2 Engine Wiring Harness to W3 Engine Wiring Harness (SE2, W2)

X5 - W3 Engine wiring Harness to W4 Engine Wiring Harness (SE2, W3)

X6 - W1 Main Wiring Harness to PTO Clutch (SE4, W1)

X7 - W1 Main Wiring Harness to W6 Engine Wiring Harness (SE5, W1; SE7, W1)

X8 - W6 Engine Wiring Harness to W7 Engine Wiring Harness (SE4, W6; SE5, W6; SE7, W6)

X9 - W7 Engine Wiring Harness to W2 and W8 Engine Wiring Harness (SE6, W7)

X10 - W6 Engine Wiring Harness to W10 Stator Wiring Harness (SE7, W6)

X11 - W1 Main Wiring Harness to Headlights (SE7, W1)

Wiring Harnesses:

W1 - Main Wiring Harness

W2 - Engine Wiring Harness

W3 - Engine Wiring Harness

W4 - Engine Wiring Harness

W5 - PTO Clutch Wiring Harness

W6 - Engine Wiring Harness

W7 - Engine Wiring Harness

W8 - Engine Wiring Harness

W9 - Engine Wiring Harness

W10 - Stator Wiring Harness

W11 - Headlight Wiring Harness

Schematic and Wiring Harness Legend - LX288 (SN - 090000)

Components:

A1 - Interlock Module (SE3, W1)

A2 - Discharge Module (SE7, W2)

B1 - Engine Oil Pressure Switch (SE5, W2)

E1 - Spark Plug (SE2, W3)

E2 - Spark Plug (SE2, W3)

E3 - R.H. Headlight (SE7, W7)

E4 - L.H. Headlight (SE7, W7)

F1 - Fusible Link (SE1, W1)

F2 - Fuse 15 amp (SE3, W1)

F3 - Fuse 15 amp (SE3, W1)

G1 - Battery (SE1, W1)

G2 - Stator (SE7, W6)

H1 - Engine Oil Pressure Light (SE5, W1)

H2 - Discharge Light (SE7, W1)

H3 - Coolant Temperature Light Socket (SE4, W1)

M1 - Starting Motor (SE1, W1)

N1 - Voltage Regulator/Rectifier (SE7, W2)

S1 - Key Switch (SE2, W1)

S2 - Seat Switch (SE3, W1)

S3 - RIO Switch (SE3, W1)

S4 - PTO/RIP Switch (SE4, W1)

S5 - Brake/Neutral Start Switch (SE5, W1)

S6 - Headlight Switch (SE7, W1)

T1 - Magneto Ignition (SE2, W3)

T2 - Magneto Ignition (SE2, W3)

V1 - Diode (SE2, W3)

V2 - Diode (SE2, W3)

W1 - Shielded Ground (SE1, W1)

Y1 - PTO Clutch (SE4, W4)

Y2 - Fuel Shutoff Solenoid (SE6, W5)

Connectors:

X1 - W1 Main Wiring Harness to S1 Key Switch (SE1, W1)

X2 - W1 Main Wiring Harness to A1 Interlock Module (SE2, W1; SE3, W1)

X3 - W1 Main Wiring Harness to A1 Interlock Module (SE2, W1; SE3, W1)

X4 - W1 Main Wiring Harness to W2 Engine Wiring Harness (SE2, W1; SE5,W1;SE7,W1)

X5 - W2 Engine Wiring Harness to W3 Engine Wiring Harness (SE2, W2)

X6 - W1 Main Wiring Harness to PTO Clutch (SE4, W1)

X7 - W2 Engine Wiring Harness to Y1 Fuel Shutoff Solenoid (SE5, W2)

X8 - W2 Engine Wiring Harness to A2 Discharge Module (SE7, W2)

X9 - W6 Stator Wiring Harness to N1 Voltage Regulator/ Rectifier (SE7, W6)

X10 - W2 Engine Wiring Harness to N1 Voltage Regulator/ Rectifier (SE7, W2)

X11 - W1 Main Wiring Harness to Headlights (SE7, W1)

Wiring Harnesses:

W1 - Main Wiring Harness

W2 - Engine Wiring Harness

W3 - Engine Wiring Harness

W4 - PTO Clutch Wiring Harness

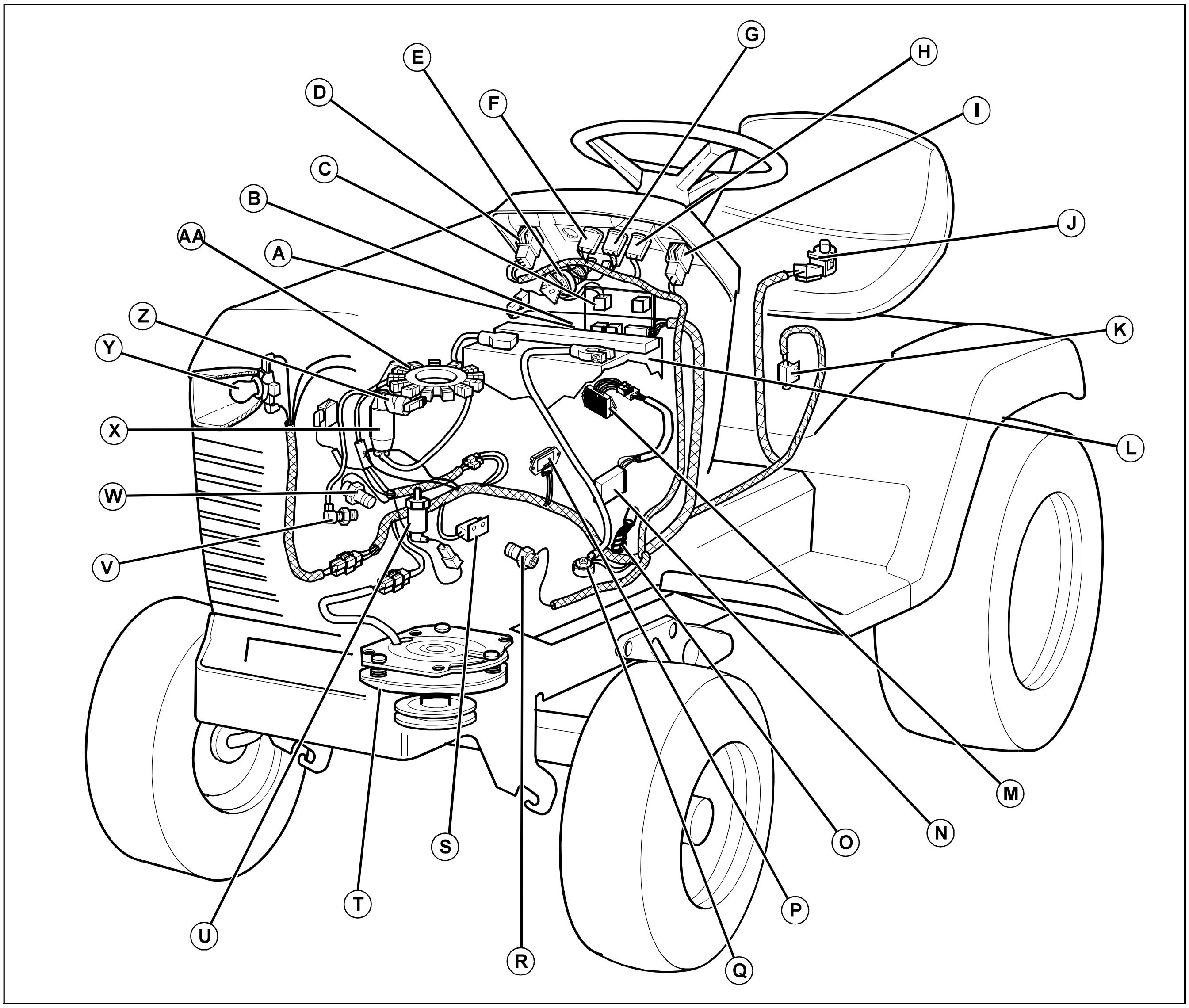
W5 - Fuel Shutoff Solenoid Wiring Harness

W6 - Stator Wiring Harness

W7 - Headlight Wiring Harness

Component Location

Electrical Components

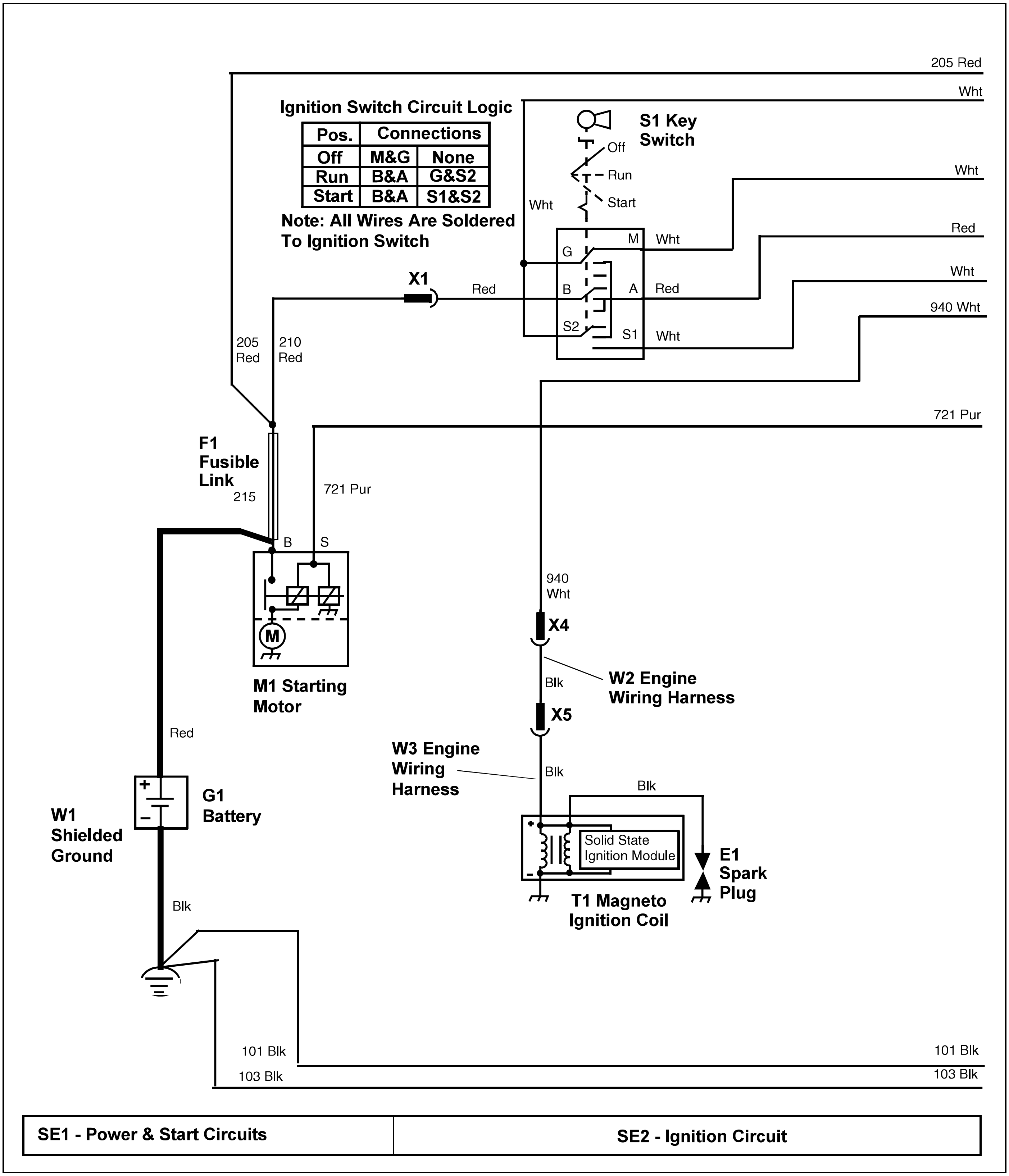


MIF

A - F3 Fuse
B - F2 Fuse
C - Interlock Module
D - PTO/RIP Switch
E - Key Switch
F - Coolant Temperature Light
G - Engine Oil Pressure Light
H - Discharge Light
I - Headlight Switch
J - Seat Switch
K - Brake/Neutral Start Switch
L - Battery
M - Voltage Regulator/Rectifier (LX279)
N - Ignition Module
O - Discharge Module
P - Voltage Regulator/Rectifier
Q - Shielded Ground
R - Oil Pressure Switch
S - RIO Switch
T - PTO Clutch
U - Fuel Shutoff Solenoid
V - Spark Plug
W - Coolant Temperature Switch
X - Starting Motor
Y - Headlight
Z - Magneto Coil
AA- Stator

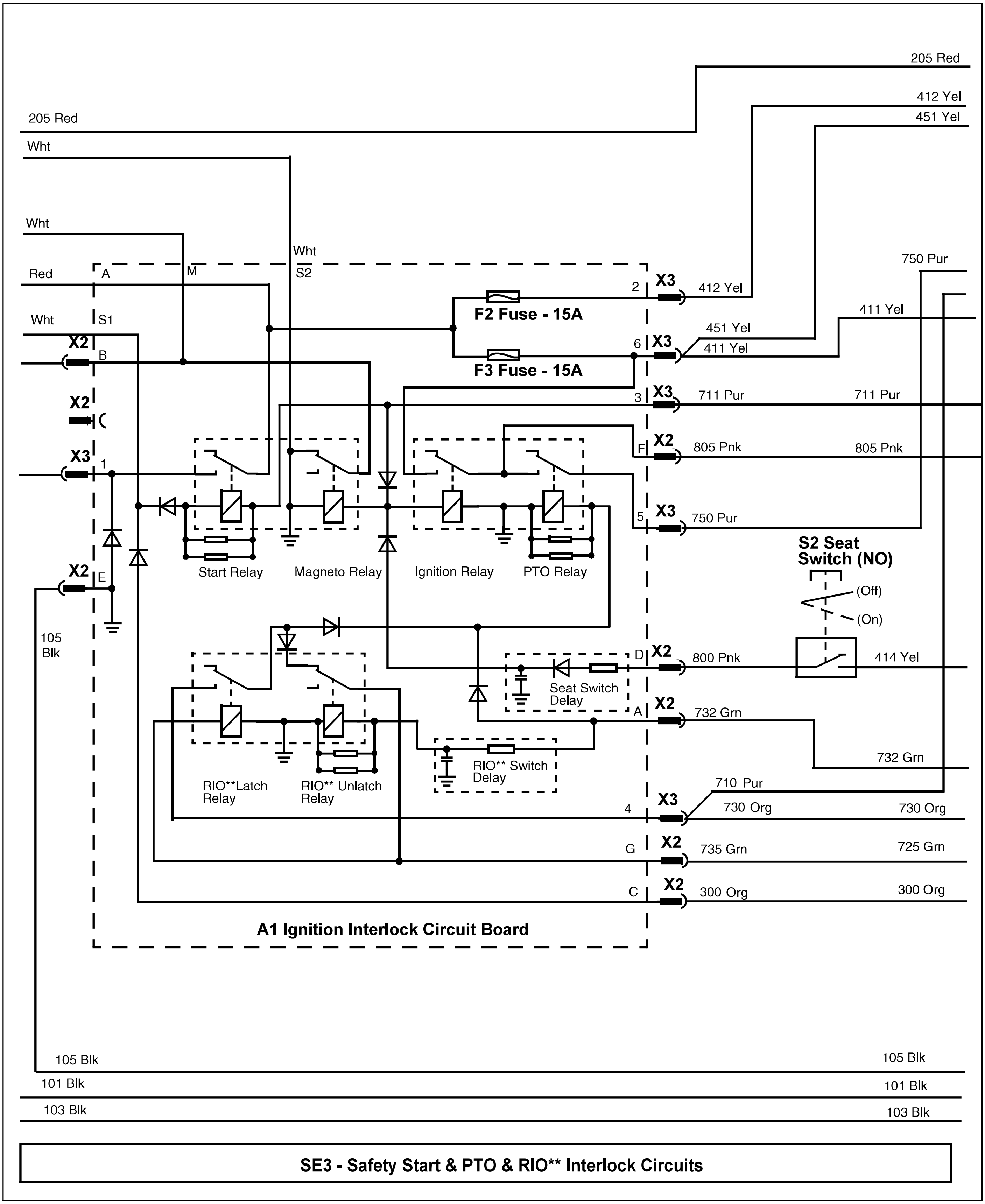
Schematics and Harnesses

LX255 and LX266 Kohler Main Electrical Schematic (1 of 4)


205 Red
Wht
Ignition Switch Circuit Logic
S1 Key Switch
Off
Run
Start
Wht
Wht
Red
Wht
940 Wht
Note: All Wires Are Soldered To Ignition Switch
G
M
Wht
X1
Red
B
A
Red
S2
S1
Wht
205 Red
210 Red
721 Pur
F1 Fusible Link
215
721 Pur
B
S
M
M1 Starting Motor
940 Wht
X4
Blk
W2 Engine Wiring Harness
X5
W3 Engine Wiring Harness
Blk
Blk
Red
G1 Battery
W1 Shielded Ground
Solid State Ignition Module
E1 Spark Plug
T1 Magneto Ignition Coil
Blk
101 Blk
103 Blk
101 Blk
103 Blk
SE1 - Power & Start Circuits
SE2 - Ignition Circuit

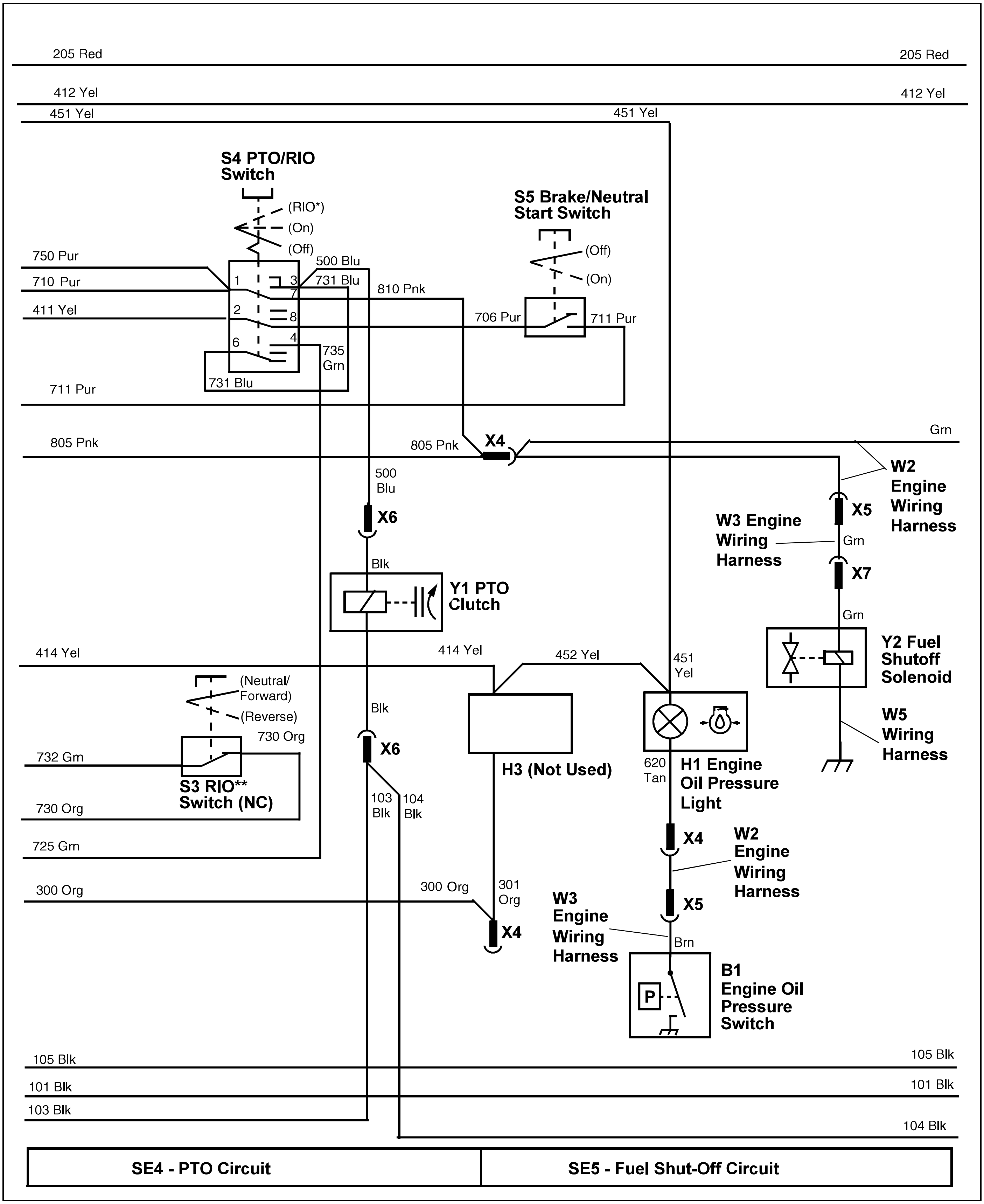
Pos.	Connections	
Off	M&G	None
Run	B&A	G&S2
Start	B&A	S1&S2

LX255 and LX266 Kohler Main Electrical Schematic (2 of 4)

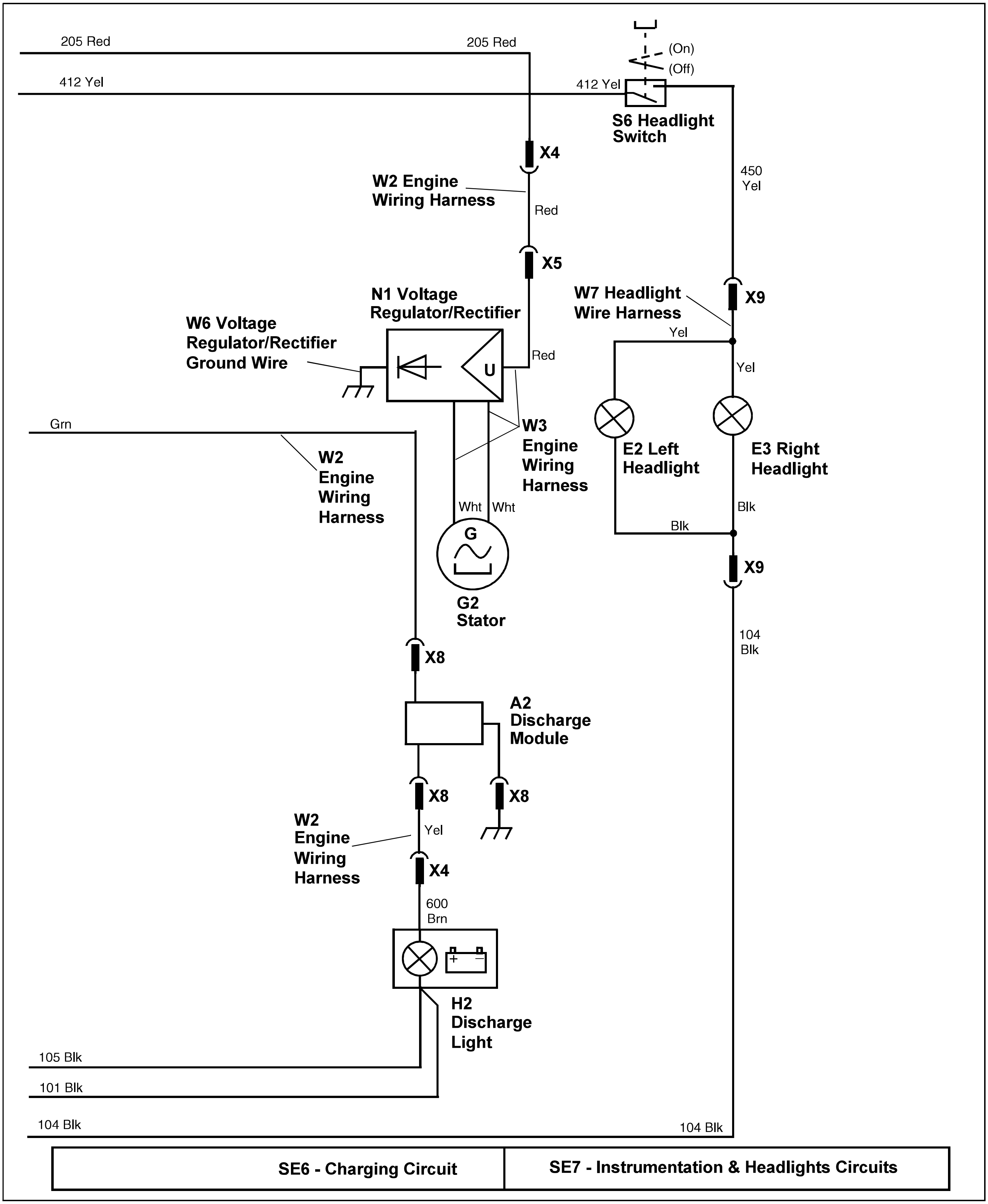

205 Red
412 Yel
451 Yel
205 Red
Wht
Wht
Wht
S2
Red
A
M
750 Pur
X3
2
412 Yel
F2 Fuse - 15A
Wht
S1
411 Yel
X2
B
451 Yel
6
X3
411 Yel
F3 Fuse - 15A
X2
X3
3
711 Pur
711 Pur
X2
F
805 Pnk
805 Pnk
X3
1
X3
5
750 Pur
S2 Seat
Switch (NO)
Start Relay
Magneto Relay
Ignition Relay
PTO Relay
X2
E
(Off)
(On)
105
Blk
D
X2
800 Pnk
414 Yel
Seat Switch
Delay
A
X2
732 Grn
732 Grn
RIO** Switch
Delay
RIO**Latch
Relay
RIO** Unlatch
Relay
710 Pur
4
X3
730 Org
730 Org
G
X2
735 Grn
725 Grn
C
X2
300 Org
300 Org
A1 Ignition Interlock Circuit Board
105 Blk
105 Blk
101 Blk
101 Blk
103 Blk
103 Blk

SE3 - Safety Start & PTO & RIO** Interlock Circuits

LX255 and LX266 Kohler Main Electrical Schematic (3 of 4)


205 Red
205 Red
412 Yel
412 Yel
451 Yel
451 Yel
S4 PTO/RIO Switch
(RIO*)
(On)
(Off)
750 Pur
710 Pur
411 Yel
500 Blu
731 Blu
810 Pnk
1
2
3
4
6
7
8
735 Grn
731 Blu
711 Pur
S5 Brake/Neutral Start Switch
(Off)
(On)
706 Pur
711 Pur
805 Pnk
805 Pnk
X4
Grn
W2 Engine Wiring Harness
500 Blu
X6
Blk
Y1 PTO Clutch
X5
W3 Engine Wiring Harness
Grn
X7
Grn
Y2 Fuel Shutoff Solenoid
W5 Wiring Harness
414 Yel
414 Yel
452 Yel
451 Yel
(Neutral/ Forward)
(Reverse)
730 Org
732 Grn
S3 RIO** Switch (NC)
730 Org
Blk
X6
103 Blk
104 Blk
H3 (Not Used)
620 Tan
H1 Engine Oil Pressure Light
X4
W2 Engine Wiring Harness
725 Grn
300 Org
300 Org
301 Org
X4
W3 Engine Wiring Harness
X5
Brn
P
B1 Engine Oil Pressure Switch
105 Blk
105 Blk
101 Blk
101 Blk
103 Blk
104 Blk
SE4 - PTO Circuit
SE5 - Fuel Shut-Off Circuit

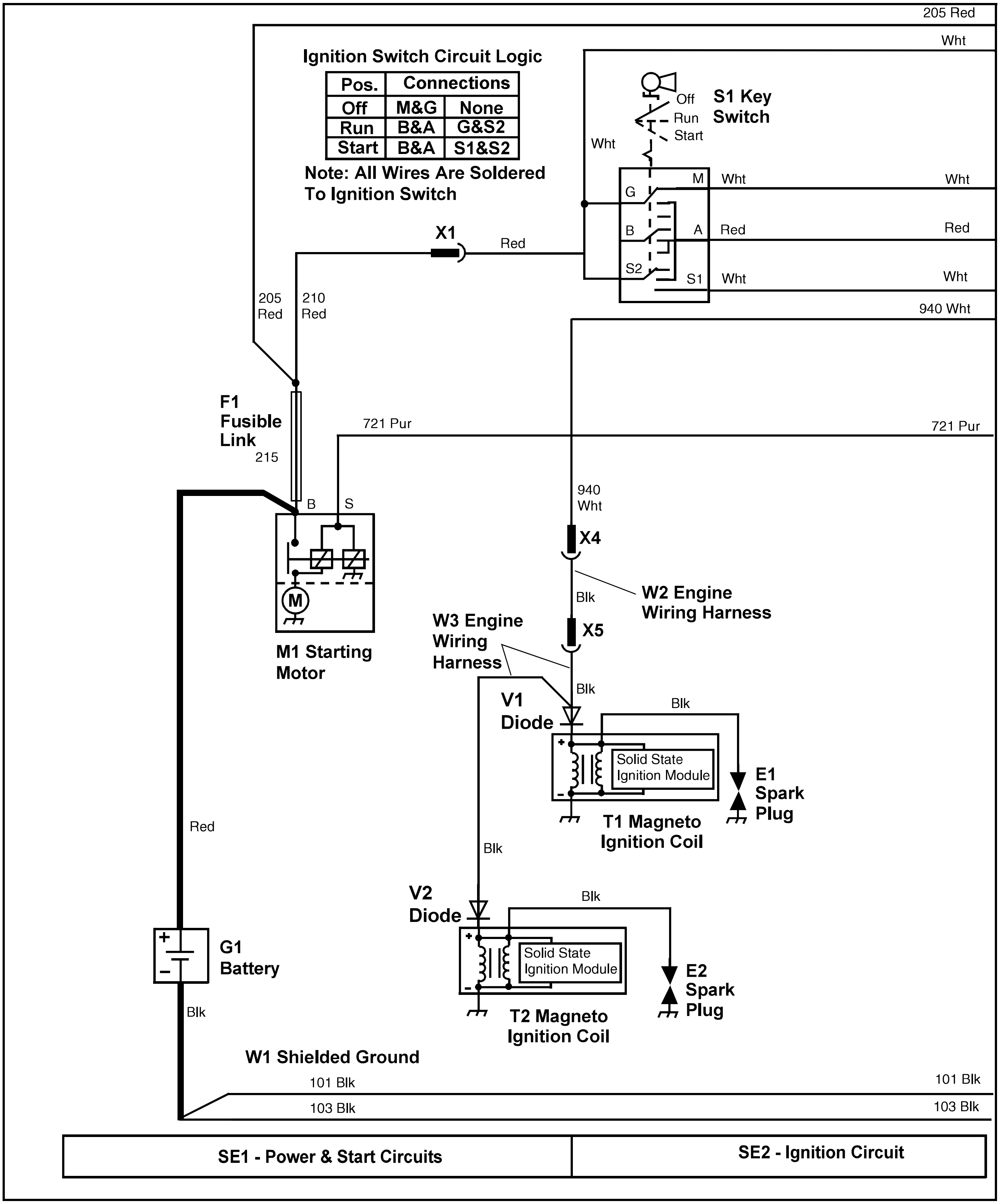
LX255 and LX266 Kohler Main Electrical Schematic (4 of 4)



205 Red
205 Red
412 Yel
412 Yel
(On)
(Off)
S6 Headlight Switch
X4
W2 Engine Wiring Harness
Red
X5
450 Yel
X9
W7 Headlight Wire Harness
Yel
Yel
N1 Voltage Regulator/Rectifier
W6 Voltage Regulator/Rectifier Ground Wire
U
Red
W3 Engine Wiring Harness
Grn
W2 Engine Wiring Harness
Wht
Wht
G
G2 Stator
E2 Left Headlight
E3 Right Headlight
Blk
Blk
X9
104 Blk
X8
A2 Discharge Module
X8
X8
W2 Engine Wiring Harness
Yel
X4
600 Brn
+
−
H2 Discharge Light
105 Blk
101 Blk
104 Blk
104 Blk
SE6 - Charging Circuit
SE7 - Instrumentation & Headlights Circuits

LX277 & LX288 (FH500V and FH580V) Main Electrical Schematic

LX277 & LX288 (FH500V and FH580V) Main Electrical Schematic (1 of 4)

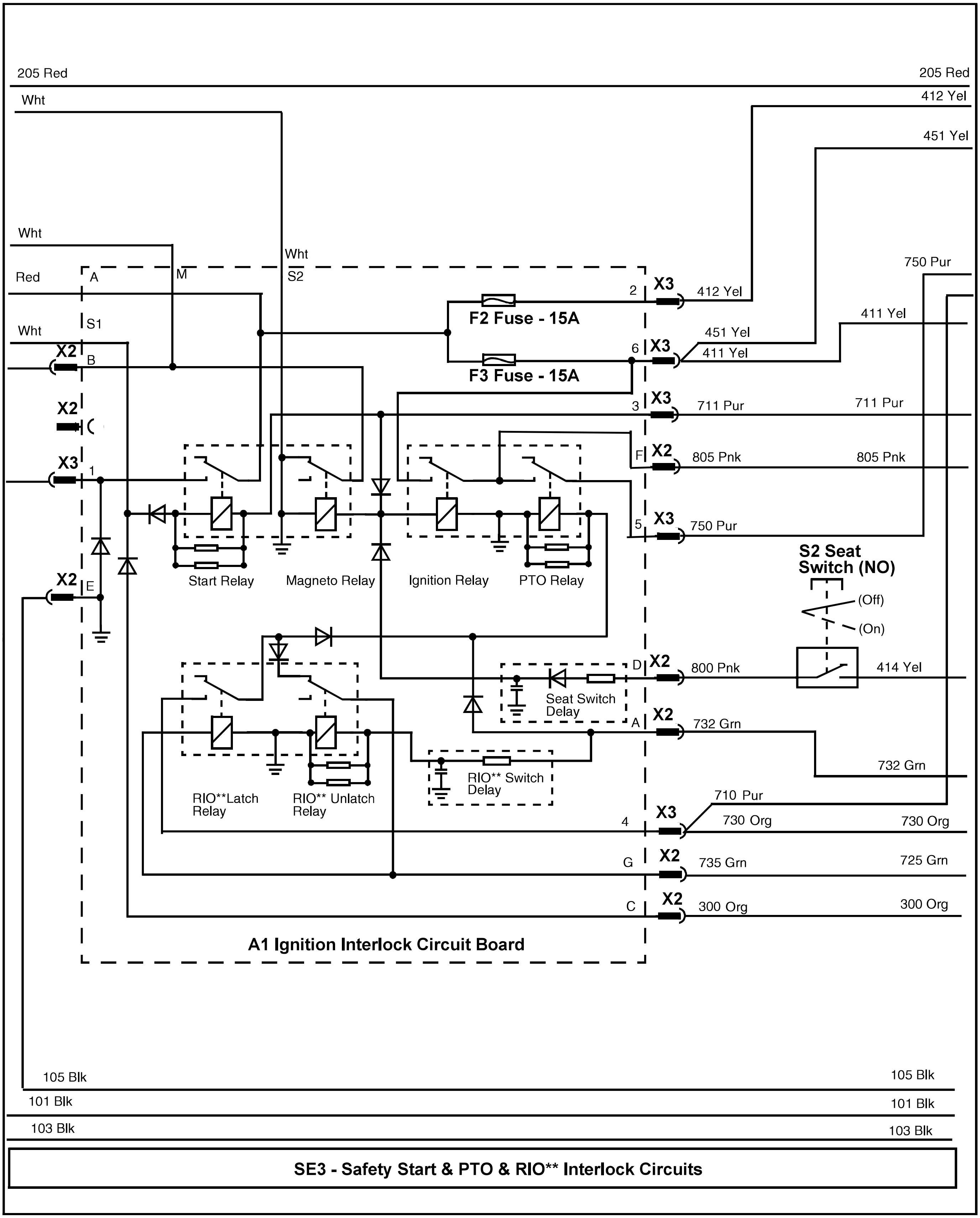

205 Red
Wht
S1 Key Switch
Off
Run
Start
Wht
G
M
Wht
Wht
B
A
Red
Red
S2
S1
Wht
Wht
X1
Red
205 Red
210 Red
940 Wht
F1 Fusible Link
215
721 Pur
721 Pur
B
S
940 Wht
X4
W2 Engine Wiring Harness
Blk
X5
M1 Starting Motor
M
W3 Engine Wiring Harness
Blk
V1 Diode
Blk
Solid State Ignition Module
E1 Spark Plug
T1 Magneto Ignition Coil
Red
Blk
V2 Diode
Blk
Solid State Ignition Module
E2 Spark Plug
G1 Battery
T2 Magneto Ignition Coil
Blk
W1 Shielded Ground
101 Blk
101 Blk
103 Blk
103 Blk
SE1 - Power & Start Circuits
SE2 - Ignition Circuit

Ignition Switch Circuit Logic

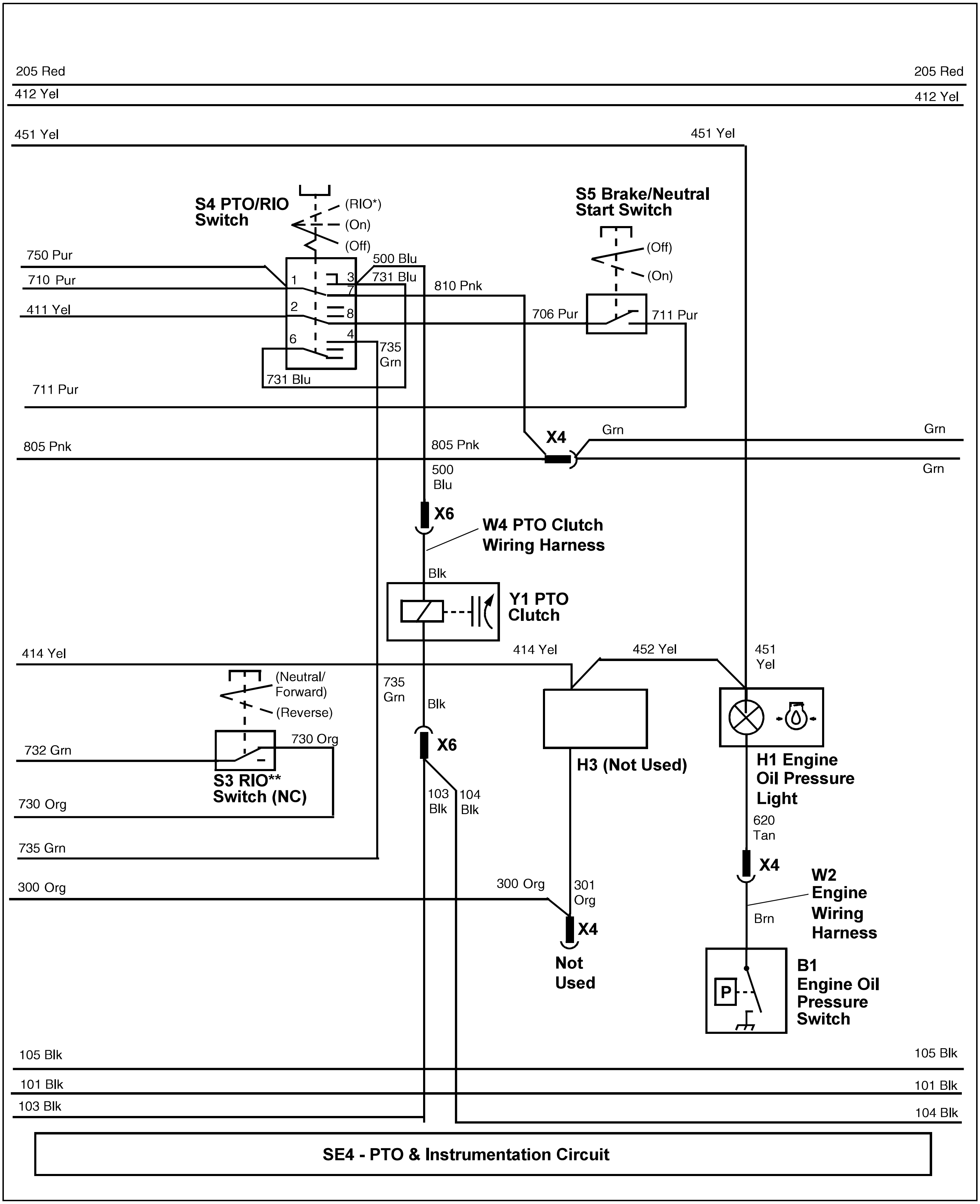
Pos.	Connections	
Off	M&G	None
Run	B&A	G&S2
Start	B&A	S1&S2

Note: All Wires Are Soldered To Ignition Switch

LX277 & LX288 (FH500V and FH580V) Main Electrical Schematic (2 of 4)

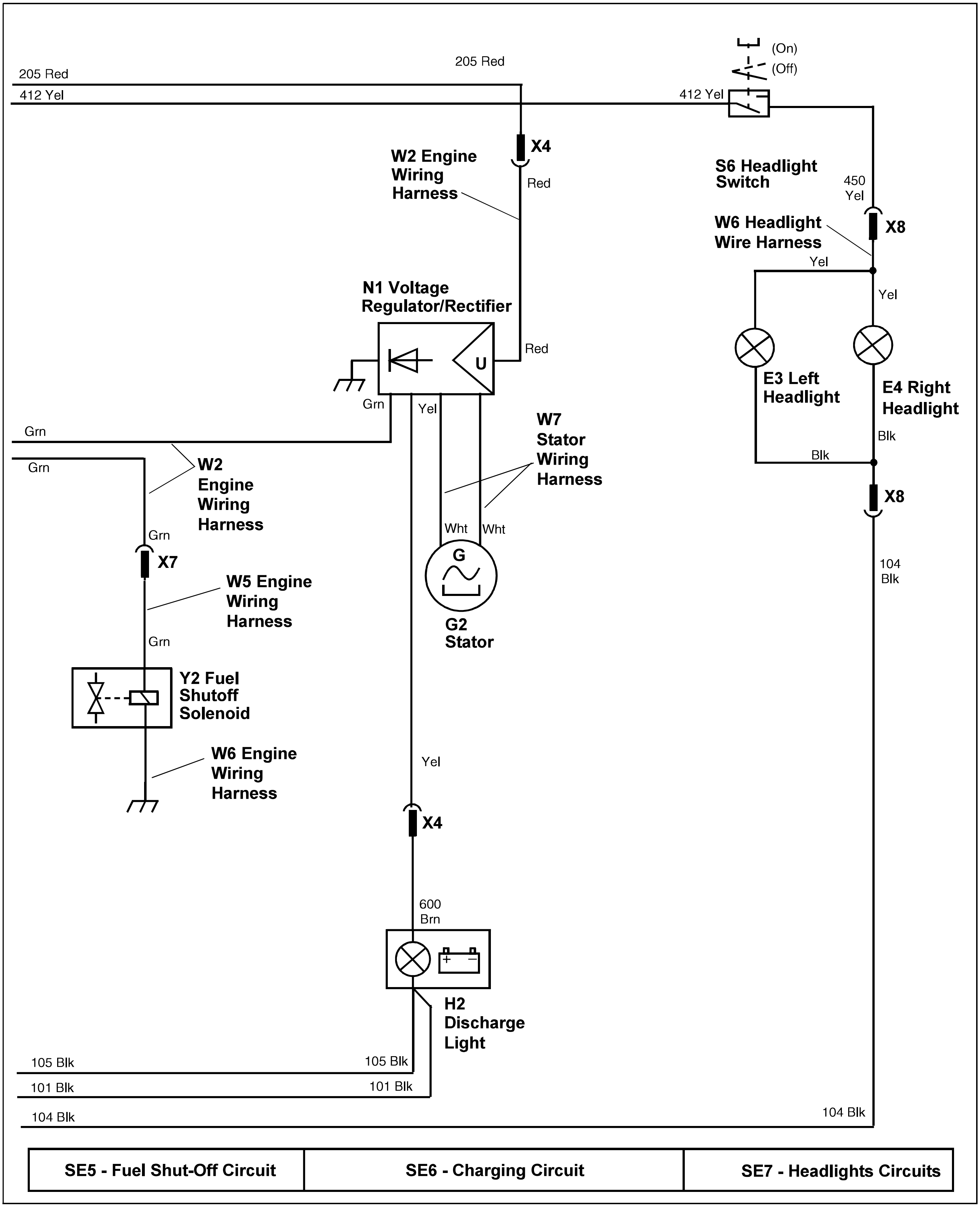

205 Red
205 Red
Wht
412 Yel
451 Yel
Wht
Wht
750 Pur
Red
A
M
S2
2
X3
412 Yel
F2 Fuse - 15A
411 Yel
Wht
S1
451 Yel
X2
B
6
X3
411 Yel
F3 Fuse - 15A
X2
X3
3
711 Pur
711 Pur
X2
F
805 Pnk
805 Pnk
X3
1
X3
5
750 Pur
S2 Seat Switch (NO)
(Off)
(On)
X2
E
Start Relay
Magneto Relay
Ignition Relay
PTO Relay
D
X2
800 Pnk
414 Yel
Seat Switch Delay
A
X2
732 Grn
732 Grn
RIO** Switch Delay
RIO**Latch Relay
RIO** Unlatch Relay
710 Pur
4
X3
730 Org
730 Org
G
X2
735 Grn
725 Grn
C
X2
300 Org
300 Org
A1 Ignition Interlock Circuit Board
105 Blk
105 Blk
101 Blk
101 Blk
103 Blk
103 Blk
SE3 - Safety Start & PTO & RIO** Interlock Circuits

LX277 & LX288 (FH500V and FH580V) Main Electrical Schematic (3 of 4)


205 Red
412 Yel
451 Yel
S4 PTO/RIO Switch
(RIO*)
(On)
(Off)
750 Pur
710 Pur
411 Yel
500 Blu
731 Blu
810 Pnk
735 Grn
731 Blu
711 Pur
S5 Brake/Neutral Start Switch
(Off)
(On)
706 Pur
711 Pur
805 Pnk
X4
Grn
500 Blu
X6
W4 PTO Clutch Wiring Harness
Blk
Y1 PTO Clutch
414 Yel
452 Yel
451 Yel
(Neutral/ Forward)
(Reverse)
732 Grn
730 Org
S3 RIO** Switch (NC)
735 Grn
103 Blk
104 Blk
H3 (Not Used)
H1 Engine Oil Pressure Light
620 Tan
W2 Engine Wiring Harness
Brn
300 Org
301 Org
Not Used
B1 Engine Oil Pressure Switch
105 Blk
101 Blk
103 Blk
104 Blk

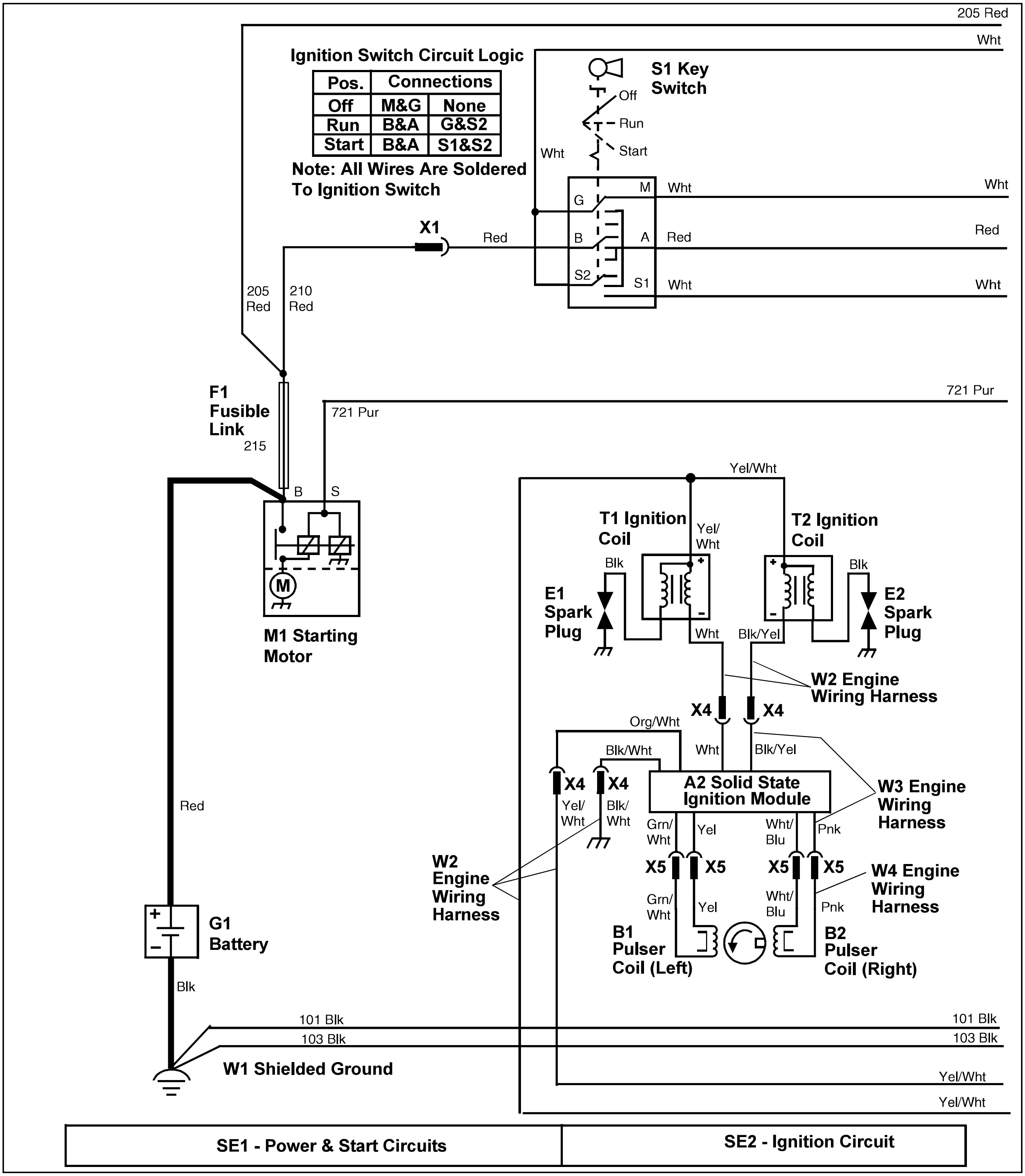
SE4 - PTO & Instrumentation Circuit

LX277 & LX288 (FH500V and FH580V) Main Electrical Schematic (4 of 4)


205 Red
412 Yel
205 Red
(On)
(Off)
412 Yel
X4
W2 Engine Wiring Harness
Red
S6 Headlight Switch
450 Yel
W6 Headlight Wire Harness
X8
Yel
Yel
N1 Voltage Regulator/Rectifier
U
Red
E3 Left Headlight
E4 Right Headlight
Grn
Yel
Grn
W7 Stator Wiring Harness
Blk
Blk
Grn
W2 Engine Wiring Harness
X8
Grn
X7
Wht
Wht
G
W5 Engine Wiring Harness
104 Blk
G2 Stator
Grn
Y2 Fuel Shutoff Solenoid
W6 Engine Wiring Harness
Yel
X4
600 Brn
H2 Discharge Light
105 Blk
105 Blk
101 Blk
101 Blk
104 Blk
104 Blk
SE5 - Fuel Shut-Off Circuit
SE6 - Charging Circuit
SE7 - Headlights Circuits

LX279 (FD501V) Main Electrical Schematic

LX279 (FD501V) Main Electrical Schematic (1 of 4)



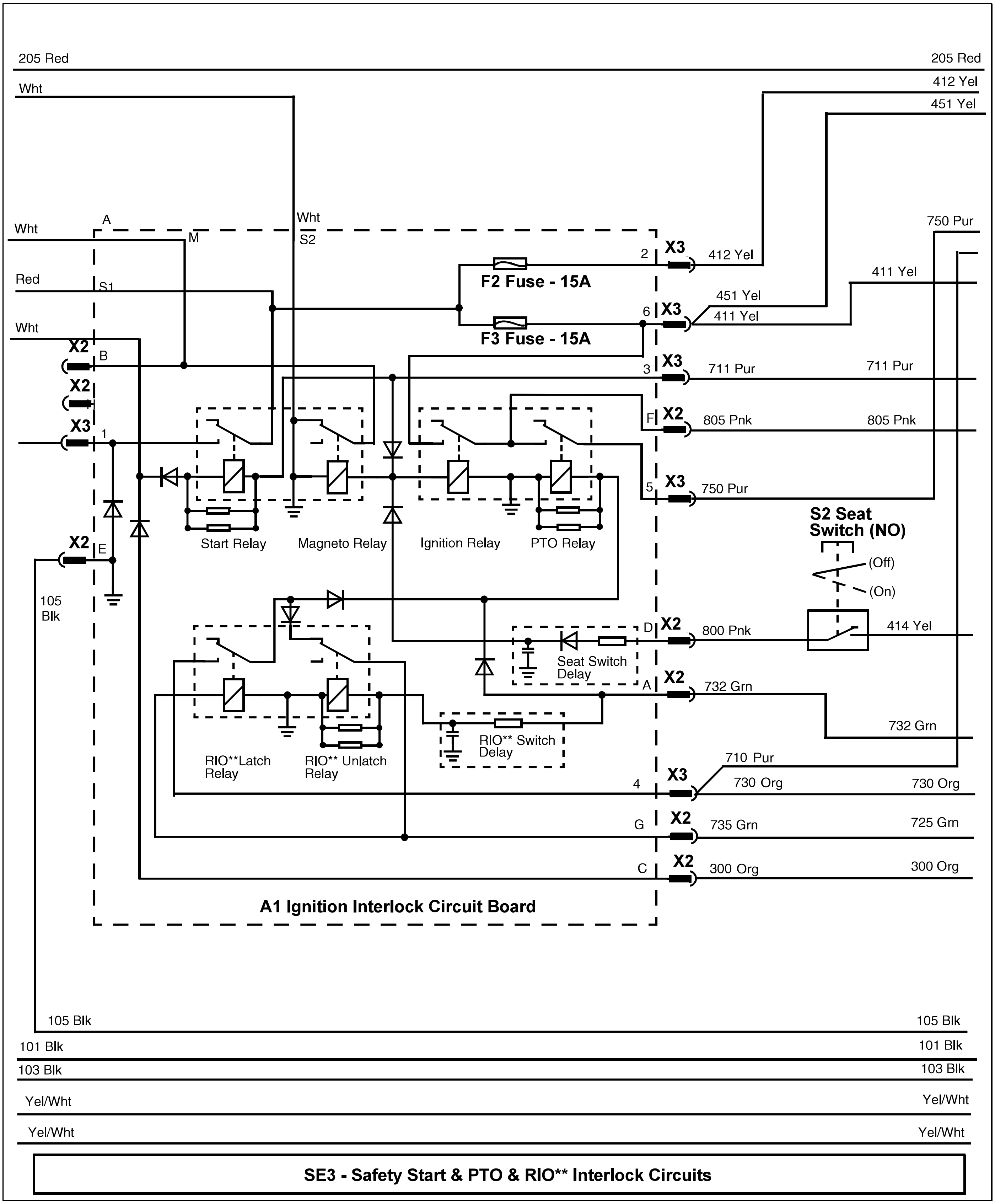
Ignition Switch Circuit Logic

Pos.	Connections	
Off	M&G	None
Run	B&A	G&S2
Start	B&A	S1&S2

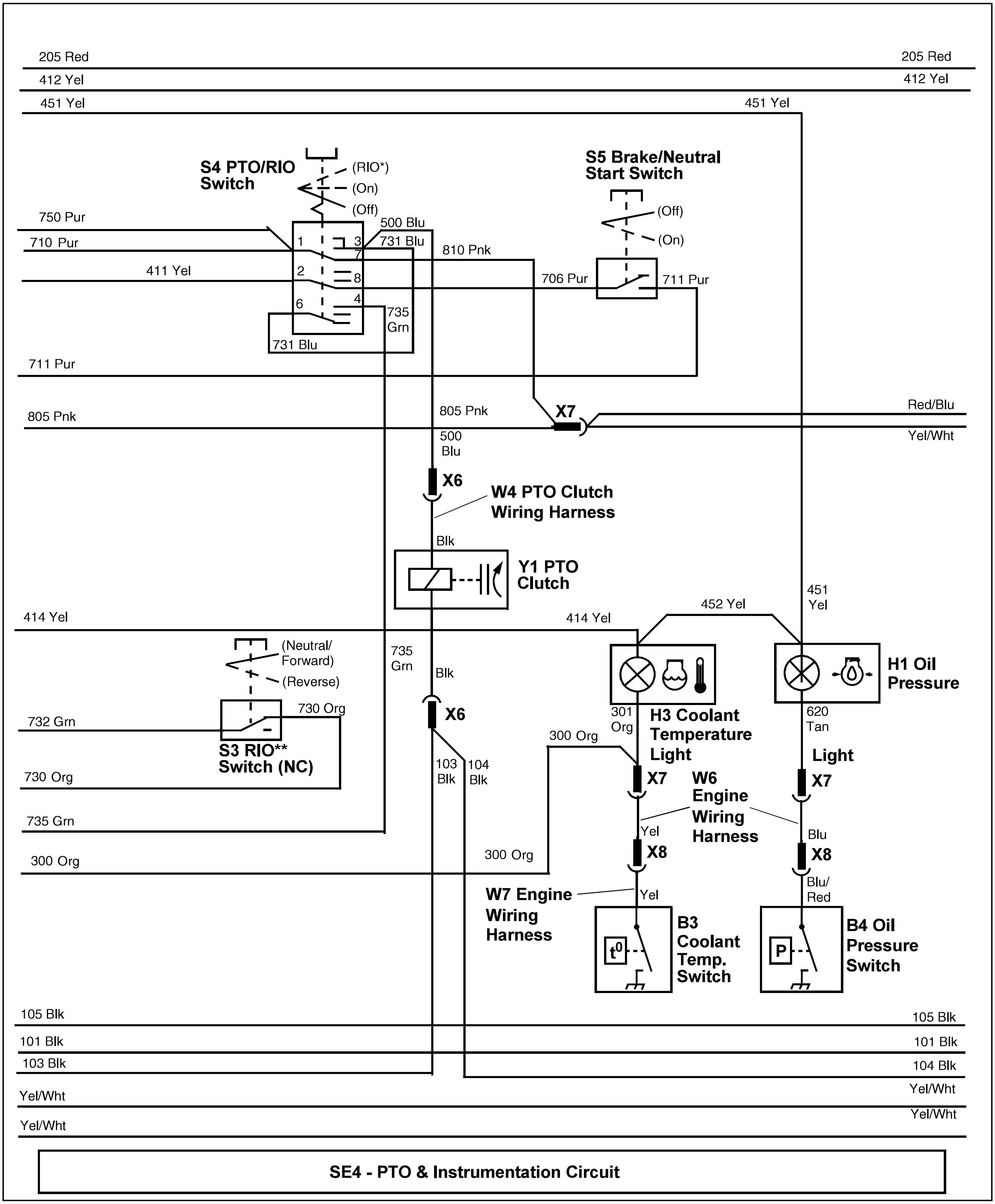
Note: All Wires Are Soldered To Ignition Switch

205 Red
Wht
S1 Key Switch
Off
Run
Start
Wht
M
Wht
Wht
G
X1
Red
B
A
Red
Red
S2
S1
Wht
Wht
205 Red
210 Red
F1 Fusible Link
215
721 Pur
721 Pur
B
S
M
M1 Starting Motor
Yel/Wht
T1 Ignition Coil
Yel/ Wht
T2 Ignition Coil
Blk
Blk
E1 Spark Plug
E2 Spark Plug
+
-
Wht
Blk/Yel
W2 Engine Wiring Harness
X4
X4
Org/Wht
Blk/Wht
Wht
Blk/Yel
X4
X4
A2 Solid State Ignition Module
W3 Engine Wiring Harness
Red
Yel/ Wht
Blk/ Wht
Grn/ Wht
Yel
Wht/ Blu
Pnk
X5
X5
X5
X5
W2 Engine Wiring Harness
W4 Engine Wiring Harness
Grn/ Wht
Yel
Wht/ Blu
Pnk
G1 Battery
B1 Pulser Coil (Left)
B2 Pulser Coil (Right)
Blk
101 Blk
101 Blk
103 Blk
103 Blk
W1 Shielded Ground
Yel/Wht
Yel/Wht
SE1 - Power & Start Circuits
SE2 - Ignition Circuit

LX279 (FD501V) Main Electrical Schematic (2 of 4)

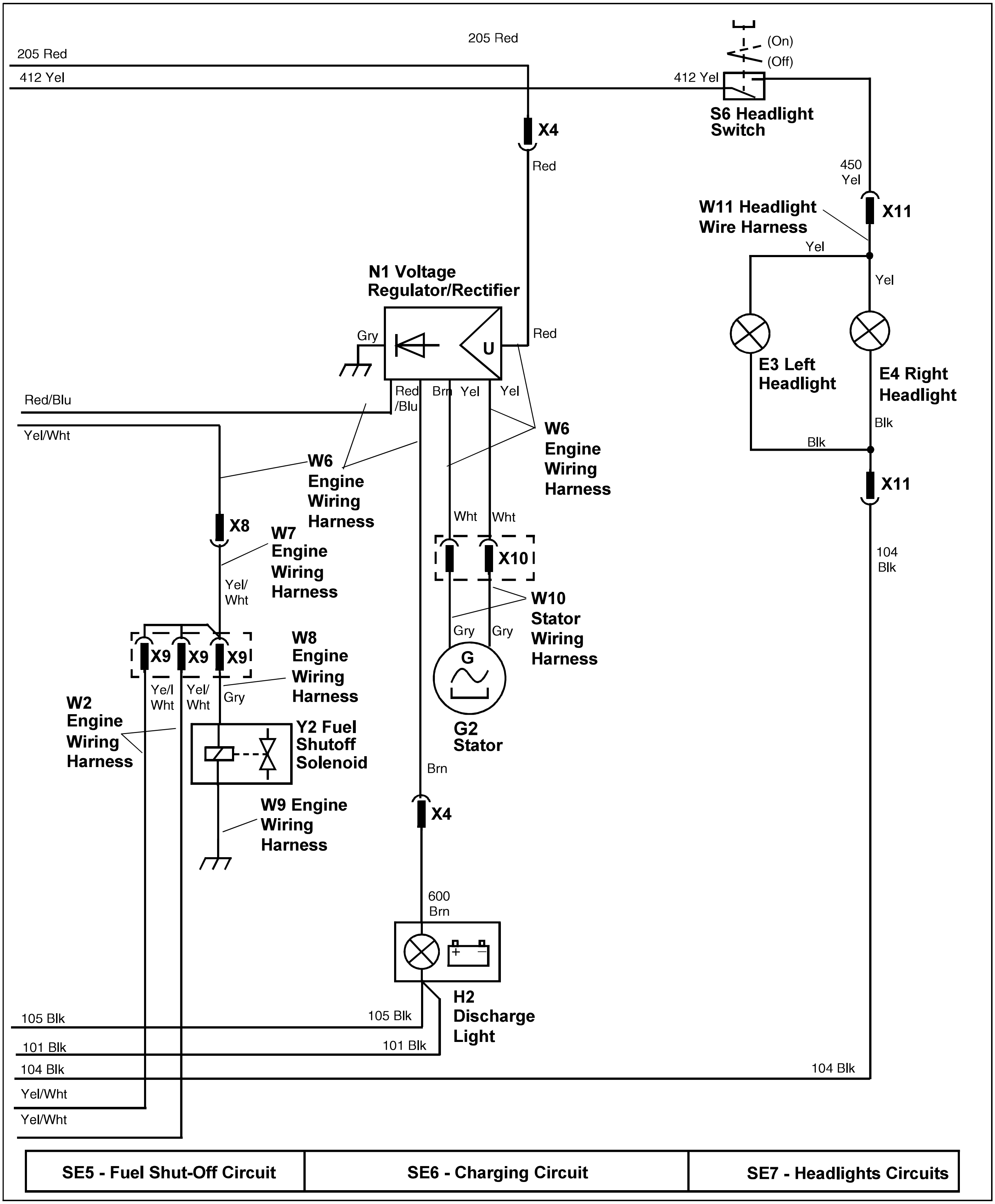

205 Red
205 Red
Wht
412 Yel
451 Yel
Wht
A
M
Wht
S2
750 Pur
Red
S1
X3
2
412 Yel
F2 Fuse - 15A
411 Yel
451 Yel
X3
6
411 Yel
F3 Fuse - 15A
Wht
X2
B
X3
3
711 Pur
711 Pur
X2
X3
1
F
X2
805 Pnk
805 Pnk
5
X3
750 Pur
Start Relay
Magneto Relay
Ignition Relay
PTO Relay
S2 Seat Switch (NO)
(Off)
(On)
X2
E
105 Blk
D
X2
800 Pnk
414 Yel
Seat Switch Delay
A
X2
732 Grn
732 Grn
RIO** Switch Delay
RIO**Latch Relay
RIO** Unlatch Relay
710 Pur
4
X3
730 Org
730 Org
G
X2
735 Grn
725 Grn
C
X2
300 Org
300 Org
A1 Ignition Interlock Circuit Board
105 Blk
105 Blk
101 Blk
101 Blk
103 Blk
103 Blk
Yel/Wht
Yel/Wht
Yel/Wht
Yel/Wht
SE3 - Safety Start & PTO & RIO** Interlock Circuits

LX279 (FD501V) Main Electrical Schematic (3 of 4)


205 Red
205 Red
412 Yel
412 Yel
451 Yel
451 Yel
S4 PTO/RIO Switch
(RIO*)
(On)
(Off)
S5 Brake/Neutral Start Switch
(Off)
(On)
750 Pur
710 Pur
500 Blu
731 Blu
810 Pnk
411 Yel
706 Pur
711 Pur
1
2
3
7
8
6
4
735 Grn
731 Blu
711 Pur
805 Pnk
805 Pnk
X7
Red/Blu
Yel/Wht
500 Blu
X6
W4 PTO Clutch Wiring Harness
Blk
Y1 PTO Clutch
451 Yel
414 Yel
452 Yel
414 Yel
(Neutral/ Forward)
(Reverse)
735 Grn
Blk
H1 Oil Pressure
730 Org
732 Grn
X6
301 Org
H3 Coolant Temperature Light
620 Tan
300 Org
Light
S3 RIO** Switch (NC)
103 Blk
104 Blk
730 Org
X7
W6 Engine Wiring Harness
X7
735 Grn
Yel
Blu
300 Org
300 Org
X8
X8
W7 Engine Wiring Harness
Yel
Blu/ Red
B3 Coolant Temp. Switch
t0
P
B4 Oil Pressure Switch
105 Blk
105 Blk
101 Blk
101 Blk
103 Blk
104 Blk
Yel/Wht
Yel/Wht
Yel/Wht
Yel/Wht

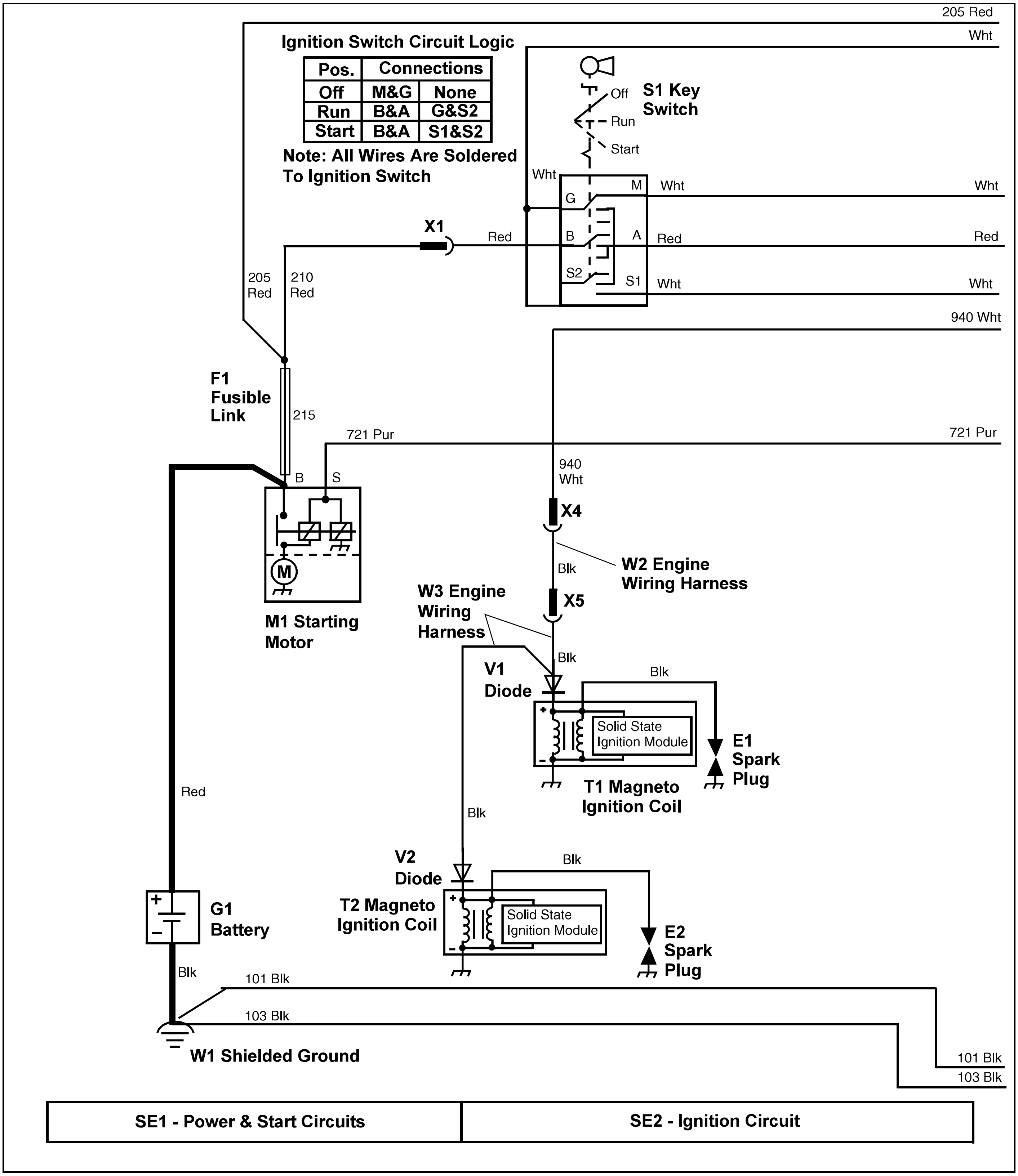
SE4 - PTO & Instrumentation Circuit

LX279 (FD501V) Main Electrical Schematic (4 of 4)


205 Red
412 Yel
205 Red
(On)
(Off)
412 Yel
S6 Headlight Switch
X4
Red
450 Yel
W11 Headlight Wire Harness
X11
Yel
Yel
N1 Voltage Regulator/Rectifier
Gry
U
Red
E3 Left Headlight
E4 Right Headlight
Red/Blu
Red /Blu
Brn
Yel
Yel
Yel/Wht
W6 Engine Wiring Harness
W6 Engine Wiring Harness
Blk
Blk
X11
X8
W7 Engine Wiring Harness
Yel/ Wht
Wht
Wht
X10
W10 Stator Wiring Harness
104 Blk
X9
X9
X9
W8 Engine Wiring Harness
Gry
Gry
G
Ye/l Wht
Yel/ Wht
Gry
W2 Engine Wiring Harness
Y2 Fuel Shutoff Solenoid
G2 Stator
Brn
W9 Engine Wiring Harness
X4
600 Brn
H2 Discharge Light
105 Blk
105 Blk
101 Blk
101 Blk
104 Blk
104 Blk
Yel/Wht
Yel/Wht
SE5 - Fuel Shut-Off Circuit
SE6 - Charging Circuit
SE7 - Headlights Circuits

LX288 (SN -090000) B&S Main Electrical Schematic

LX288 (SN -090000) B&S Main Electrical Schematic (1 of 4)



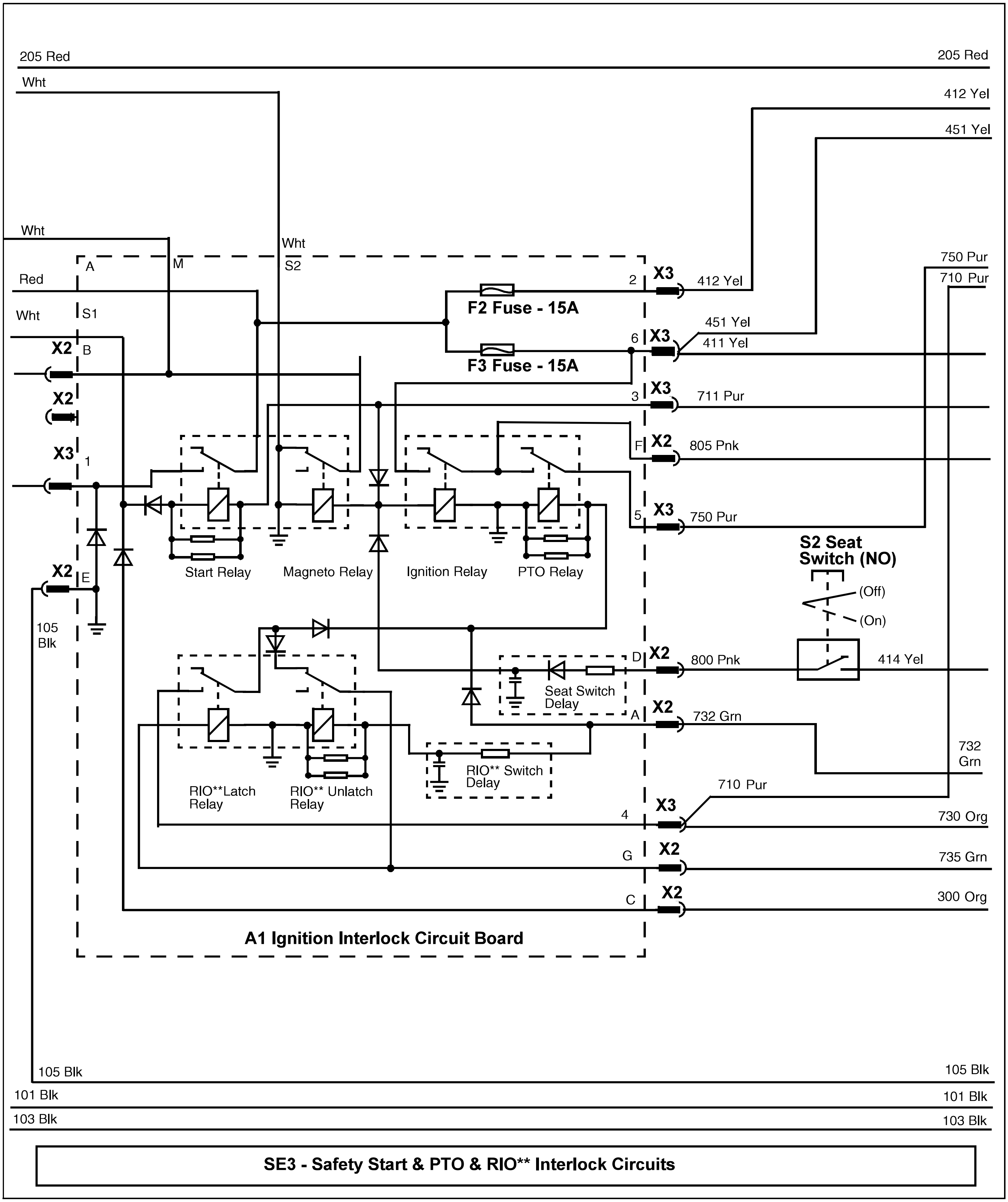
Ignition Switch Circuit Logic

Pos.	Connections	
Off	M&G	None
Run	B&A	G&S2
Start	B&A	S1&S2

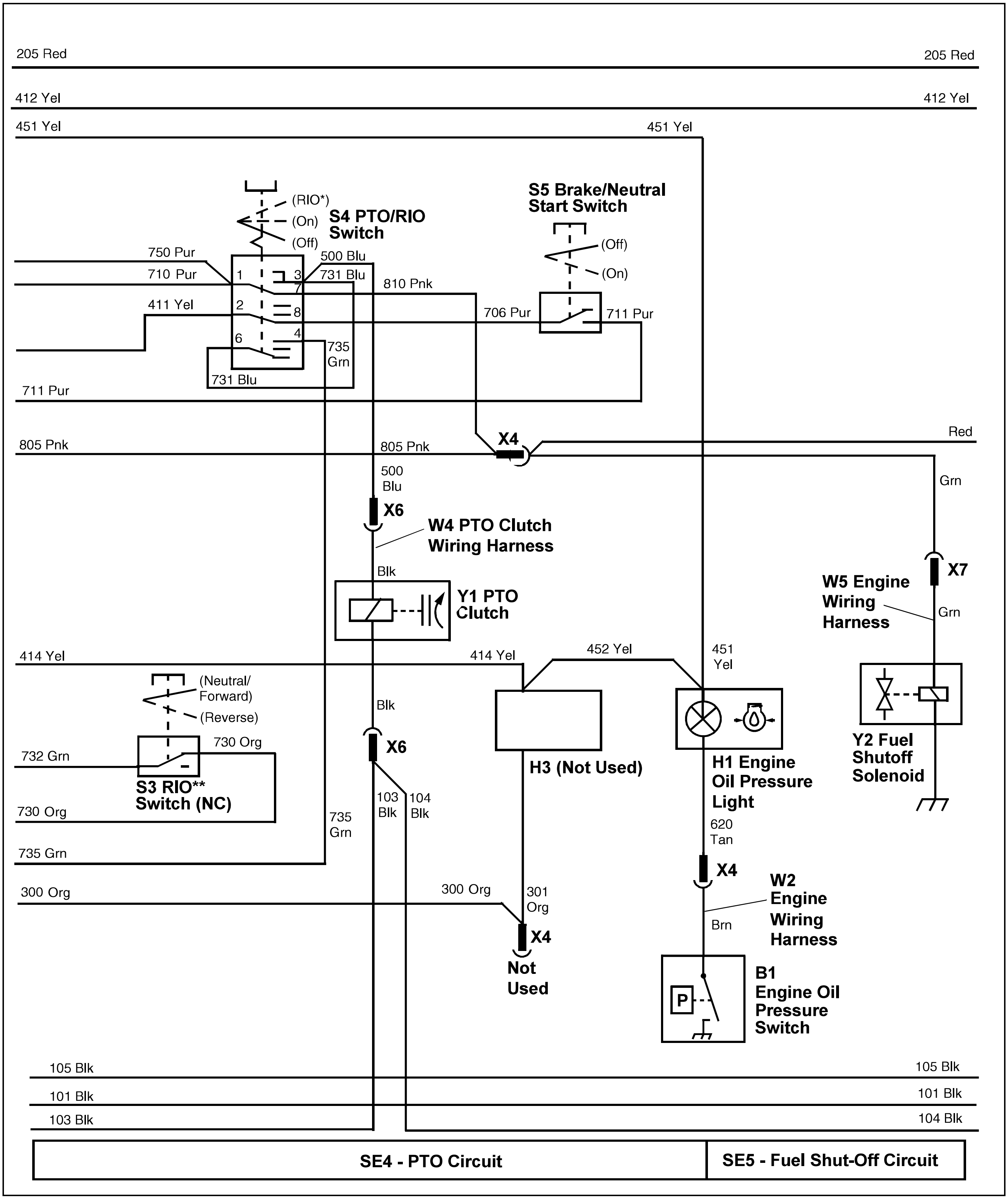
Note: All Wires Are Soldered To Ignition Switch

205 Red
Wht
S1 Key Switch
Off
Run
Start
Wht
G
M
Wht
Wht
X1
Red
B
A
Red
Red
S2
S1
Wht
Wht
205 Red
210 Red
940 Wht
F1 Fusible Link
215
721 Pur
721 Pur
B
S
940 Wht
X4
M
W2 Engine Wiring Harness
Blk
X5
W3 Engine Wiring Harness
M1 Starting Motor
Blk
V1 Diode
Blk
+
Solid State Ignition Module
E1 Spark Plug
T1 Magneto Ignition Coil
Red
Blk
V2 Diode
Blk
T2 Magneto Ignition Coil
+
Solid State Ignition Module
E2 Spark Plug
G1 Battery
Blk
101 Blk
103 Blk
W1 Shielded Ground
101 Blk
103 Blk
SE1 - Power & Start Circuits
SE2 - Ignition Circuit

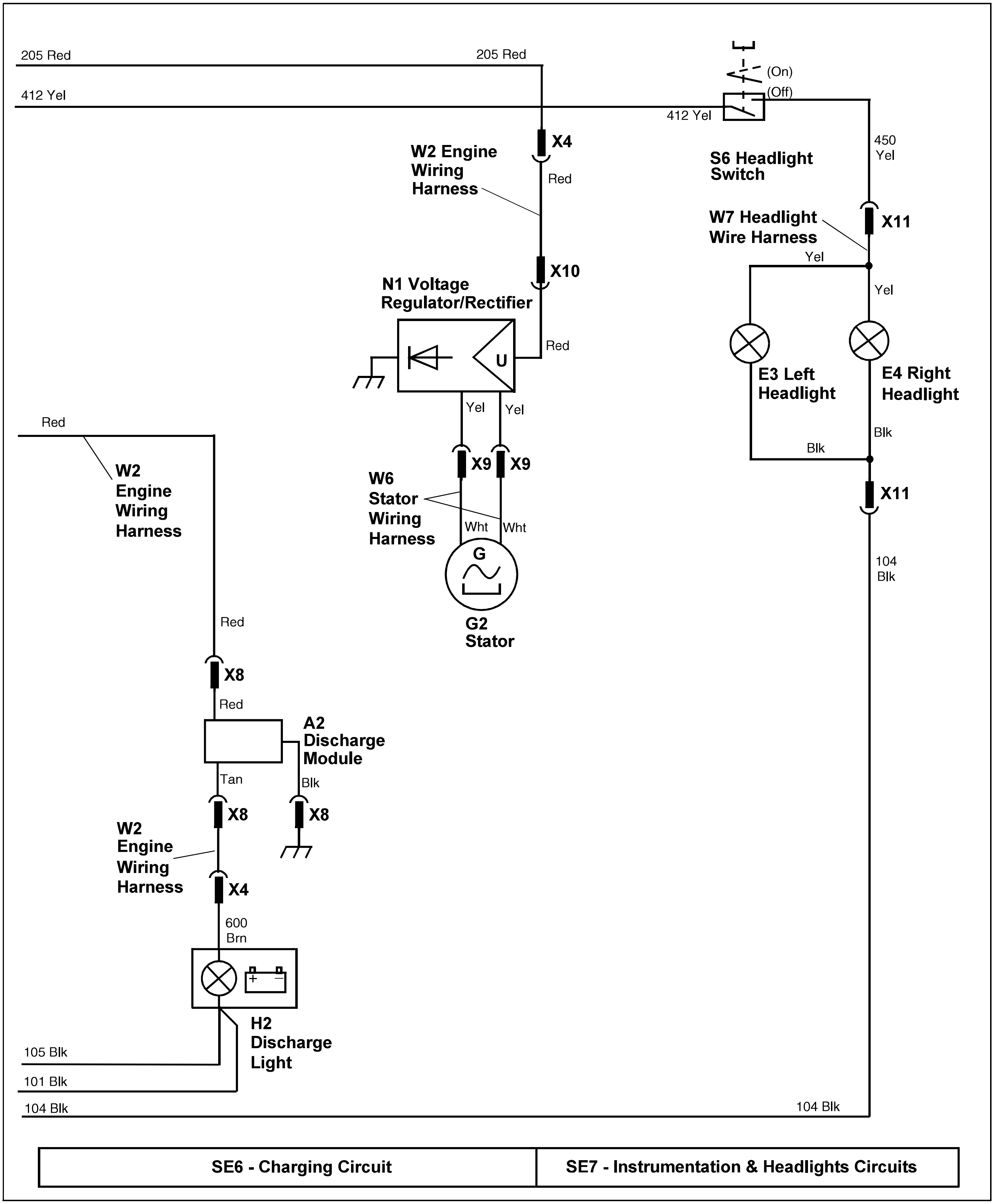
LX288 (SN -090000) B&S Main Electrical Schematic (2 of 4)


205 Red
205 Red
Wht
412 Yel
451 Yel
Wht
Wht
S2
A
M
Red
750 Pur
710 Pur
X3
2
412 Yel
F2 Fuse - 15A
Wht
S1
X2
B
6
X3
451 Yel
411 Yel
F3 Fuse - 15A
X2
3
X3
711 Pur
F
X2
805 Pnk
X3
1
5
X3
750 Pur
S2 Seat Switch (NO)
Start Relay
Magneto Relay
Ignition Relay
PTO Relay
X2
E
(Off)
(On)
105 Blk
D
X2
800 Pnk
414 Yel
Seat Switch Delay
A
X2
732 Grn
732 Grn
RIO**Latch Relay
RIO** Unlatch Relay
RIO** Switch Delay
710 Pur
4
X3
730 Org
G
X2
735 Grn
C
X2
300 Org
A1 Ignition Interlock Circuit Board
105 Blk
105 Blk
101 Blk
101 Blk
103 Blk
103 Blk
SE3 - Safety Start & PTO & RIO** Interlock Circuits

LX288 (SN -090000) B&S Main Electrical Schematic (3 of 4)


205 Red
205 Red
412 Yel
412 Yel
451 Yel
451 Yel
(RIO*)
(On)
(Off)
S4 PTO/RIO Switch
S5 Brake/Neutral Start Switch
(Off)
(On)
750 Pur
710 Pur
411 Yel
500 Blu
731 Blu
810 Pnk
706 Pur
711 Pur
1
2
3
4
6
7
8
735 Grn
731 Blu
711 Pur
805 Pnk
805 Pnk
X4
Red
Grn
500 Blu
X6
W4 PTO Clutch Wiring Harness
Blk
Y1 PTO Clutch
X7
W5 Engine Wiring Harness
Grn
414 Yel
414 Yel
452 Yel
451 Yel
(Neutral/ Forward)
(Reverse)
730 Org
732 Grn
S3 RIO** Switch (NC)
730 Org
Blk
X6
H3 (Not Used)
H1 Engine Oil Pressure Light
Y2 Fuel Shutoff Solenoid
103 Blk
104 Blk
735 Grn
735 Grn
620 Tan
X4
W2 Engine Wiring Harness
Brn
300 Org
300 Org
301 Org
X4
Not Used
P
B1 Engine Oil Pressure Switch
105 Blk
105 Blk
101 Blk
101 Blk
103 Blk
104 Blk
SE4 - PTO Circuit
SE5 - Fuel Shut-Off Circuit

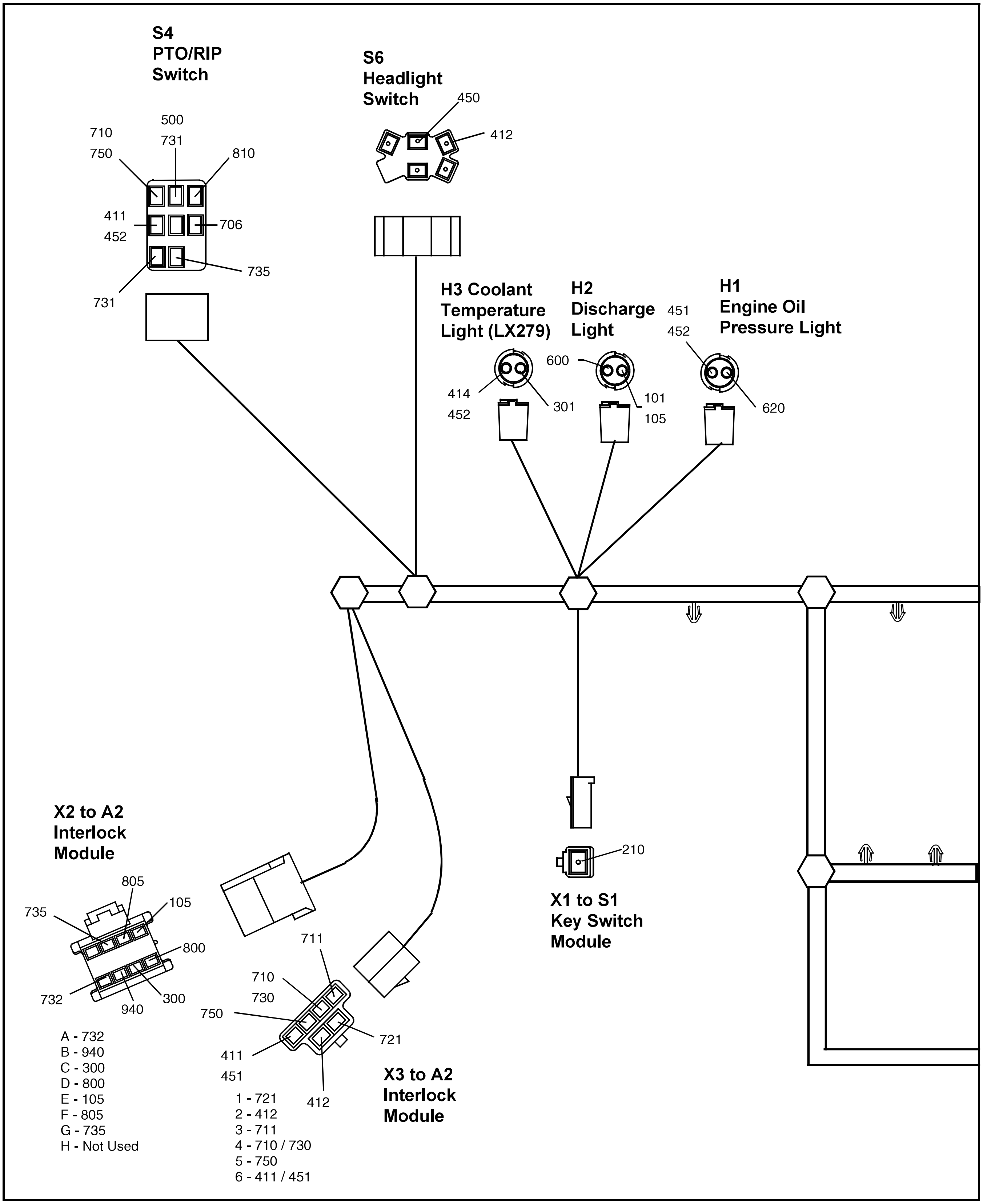
LX288 (SN -090000) B&S Main Electrical Schematic (4 of 4)


205 Red
205 Red
412 Yel
(On)
(Off)
412 Yel
X4
W2 Engine Wiring Harness
Red
450 Yel
S6 Headlight Switch
W7 Headlight Wire Harness
X11
Yel
X10
Yel
N1 Voltage Regulator/Rectifier
U
Red
E3 Left Headlight
E4 Right Headlight
Yel
Yel
Red
Blk
Blk
W2 Engine Wiring Harness
X9
X9
X11
W6 Stator Wiring Harness
Wht
Wht
G
104 Blk
G2 Stator
Red
X8
Red
A2 Discharge Module
Tan
Blk
X8
X8
W2 Engine Wiring Harness
X4
600 Brn
H2 Discharge Light
105 Blk
101 Blk
104 Blk
104 Blk

SE6 - Charging Circuit	SE7 - Instrumentation & Headlights Circuits

Main Wiring Harness - All Machines

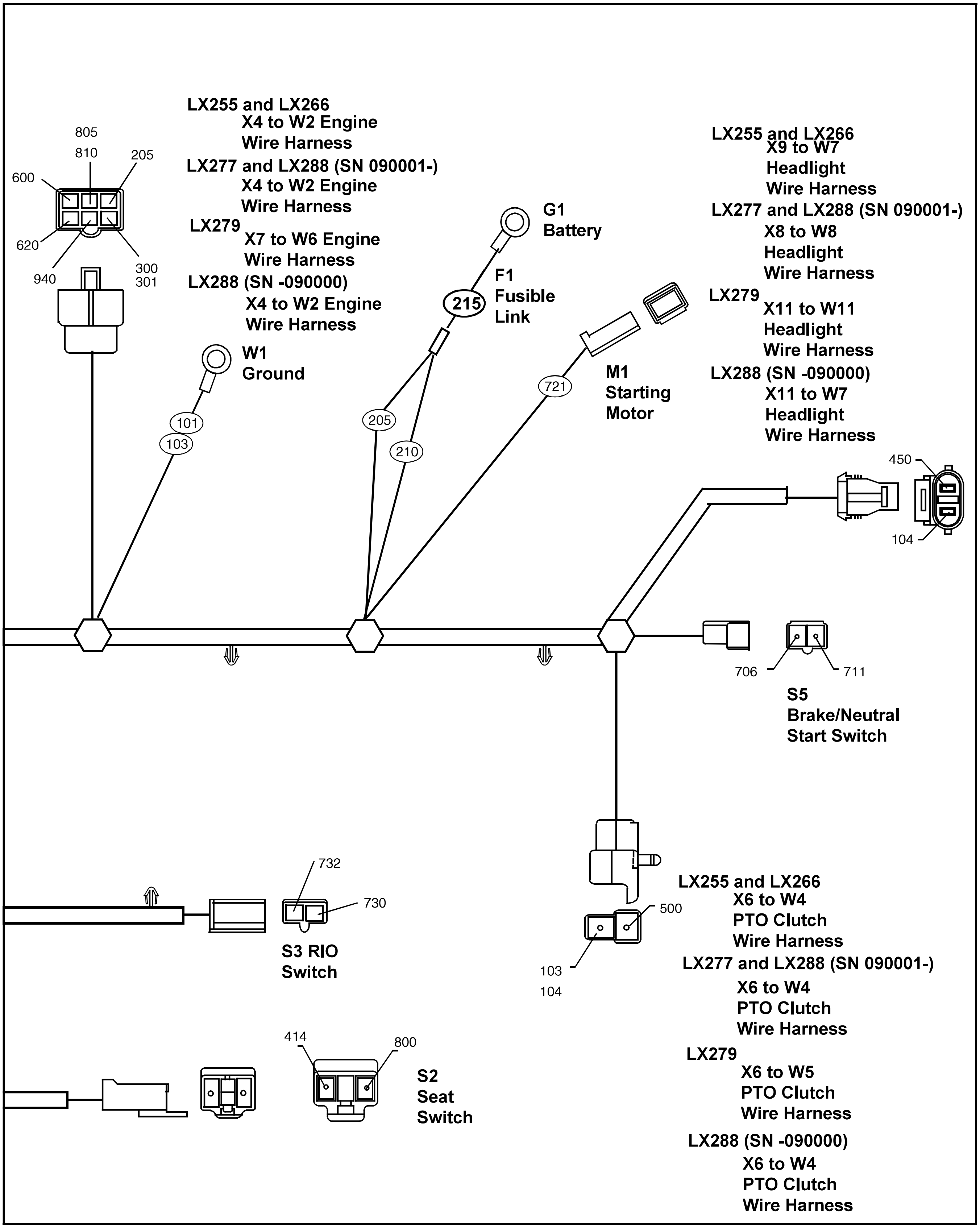
Main Wiring Harness - All Machines (1 of 2)


S4
PTO/RIP
Switch
500
731
710
750
810
411
452
706
735
731
S6
Headlight
Switch
450
412
H3 Coolant
Temperature
Light (LX279)
414
452
301
H2
Discharge
Light
600
101
105
H1
Engine Oil
Pressure Light
451
452
620
X2 to A2
Interlock
Module
805
735
105
800
732
940
300
711
710
730
750
721
411
451
412
X3 to A2
Interlock
Module
210
X1 to S1
Key Switch
Module

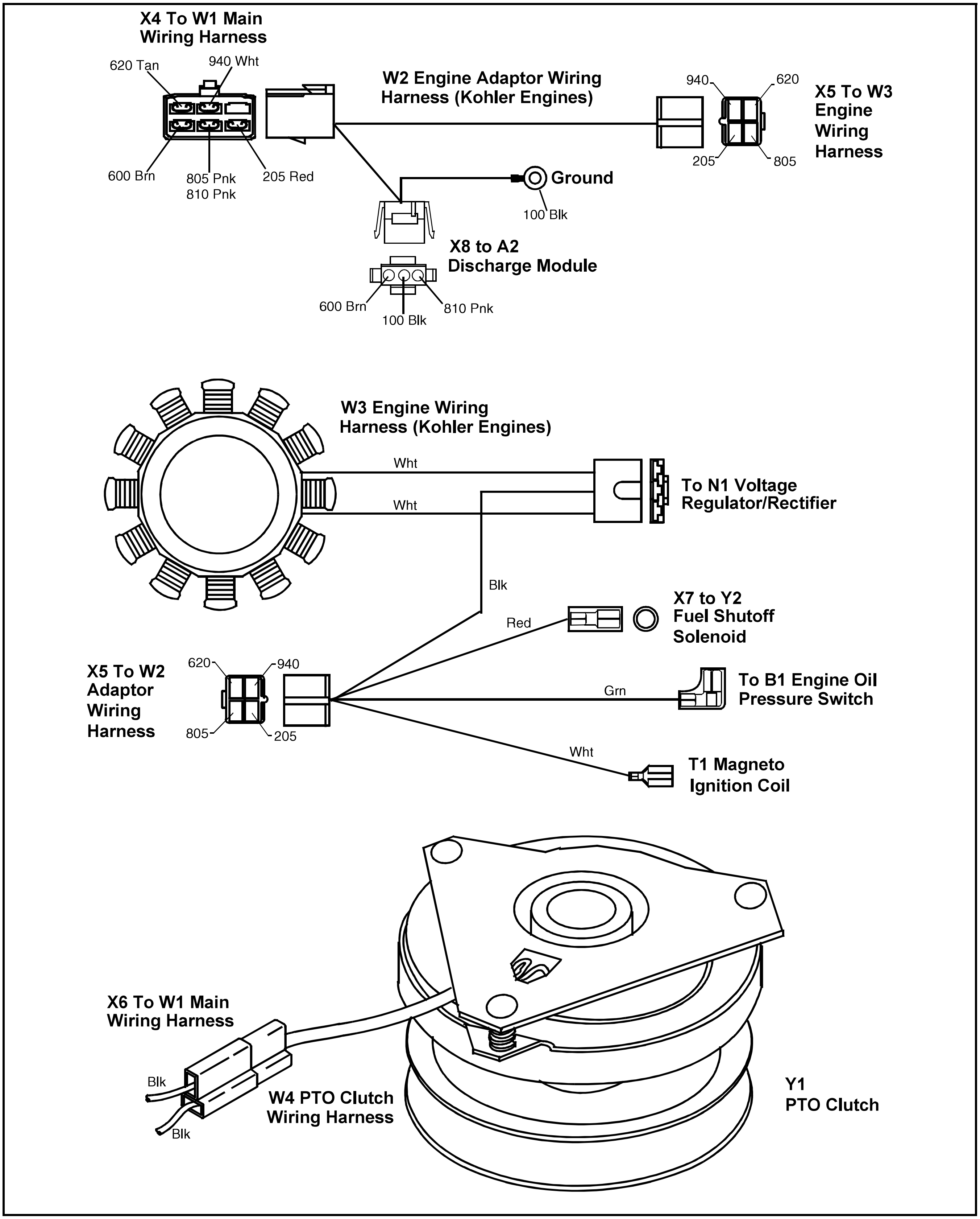
A - 732
B - 940
C - 300
D - 800
E - 105
F - 805
G - 735
H - Not Used

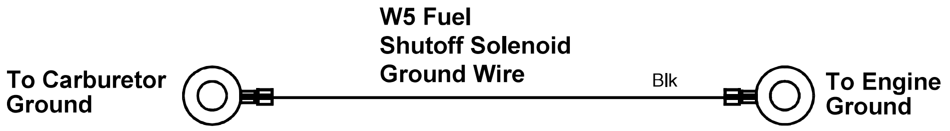
1 - 721
2 - 412
3 - 711
4 - 710 / 730
5 - 750
6 - 411 / 451

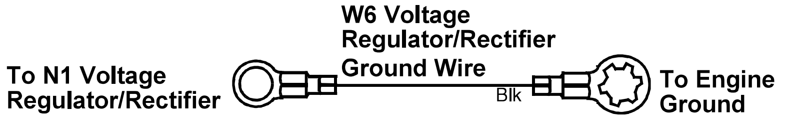
Main Wiring Harness - All Machines (2 of 2)

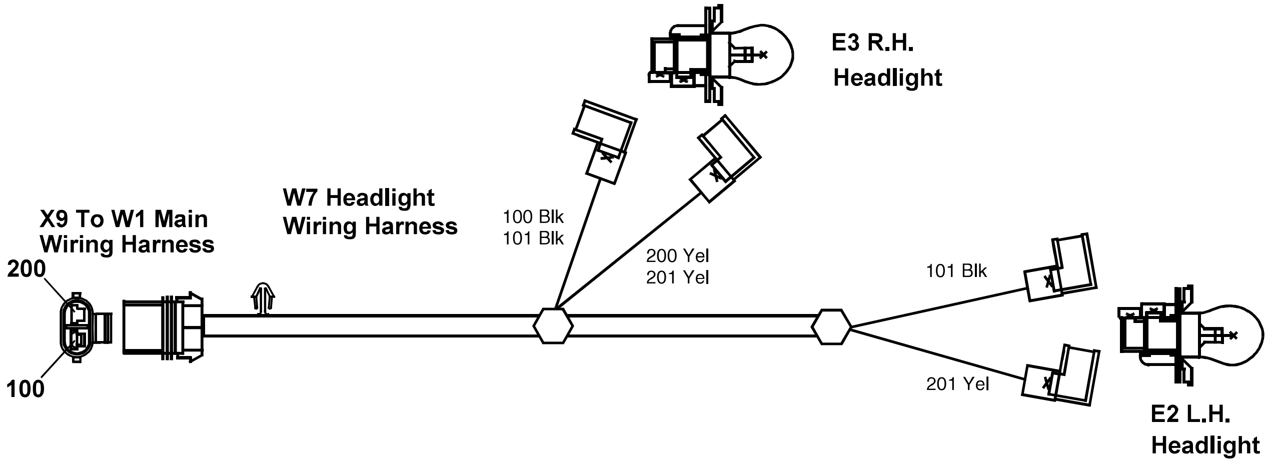

805
810
205
600
620
940
300
301
LX255 and LX266
X4 to W2 Engine
Wire Harness
LX277 and LX288 (SN 090001-)
X4 to W2 Engine
Wire Harness
LX279
X7 to W6 Engine
Wire Harness
LX288 (SN -090000)
X4 to W2 Engine
Wire Harness
W1
Ground
101
103
G1
Battery
F1
Fusible
Link
215
205
210
M1
Starting
Motor
721
LX255 and LX266
X9 to W7
Headlight
Wire Harness
LX277 and LX288 (SN 090001-)
X8 to W8
Headlight
Wire Harness
LX279
X11 to W11
Headlight
Wire Harness
LX288 (SN -090000)
X11 to W7
Headlight
Wire Harness
450
104
706
711
S5
Brake/Neutral
Start Switch
732
730
S3 RIO
Switch
500
103
104
LX255 and LX266
X6 to W4
PTO Clutch
Wire Harness
LX277 and LX288 (SN 090001-)
X6 to W4
PTO Clutch
Wire Harness
LX279
X6 to W5
PTO Clutch
Wire Harness
LX288 (SN -090000)
X6 to W4
PTO Clutch
Wire Harness
414
800
S2
Seat
Switch

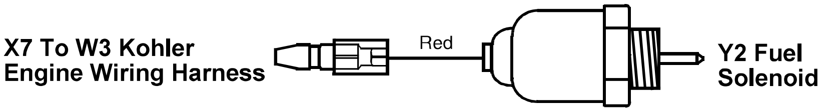
LX255 and LX266 Kohler Engine Wiring Harness

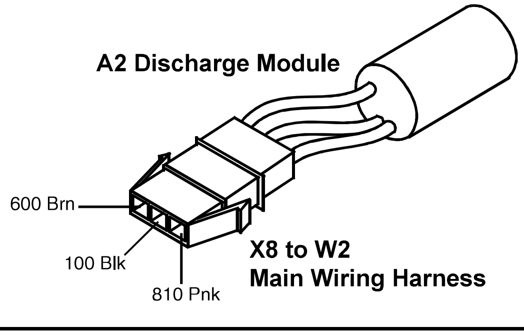

X4 To W1 Main Wiring Harness
620 Tan
940 Wht
600 Brn
805 Pnk
810 Pnk
205 Red
W2 Engine Adaptor Wiring Harness (Kohler Engines)
940
620
205
805
X5 To W3 Engine Wiring Harness
Ground
100 Blk
X8 to A2 Discharge Module
600 Brn
100 Blk
810 Pnk
W3 Engine Wiring Harness (Kohler Engines)
Wht
Wht
To N1 Voltage Regulator/Rectifier
Blk
Red
X7 to Y2 Fuel Shutoff Solenoid
X5 To W2 Adaptor Wiring Harness
620
940
805
205
Grn
To B1 Engine Oil Pressure Switch
Wht
T1 Magneto Ignition Coil
X6 To W1 Main Wiring Harness
Blk
Blk
W4 PTO Clutch Wiring Harness
Y1 PTO Clutch


W5 Fuel
Shutoff Solenoid
Ground Wire
To Carburetor
Ground
Blk
To Engine
Ground

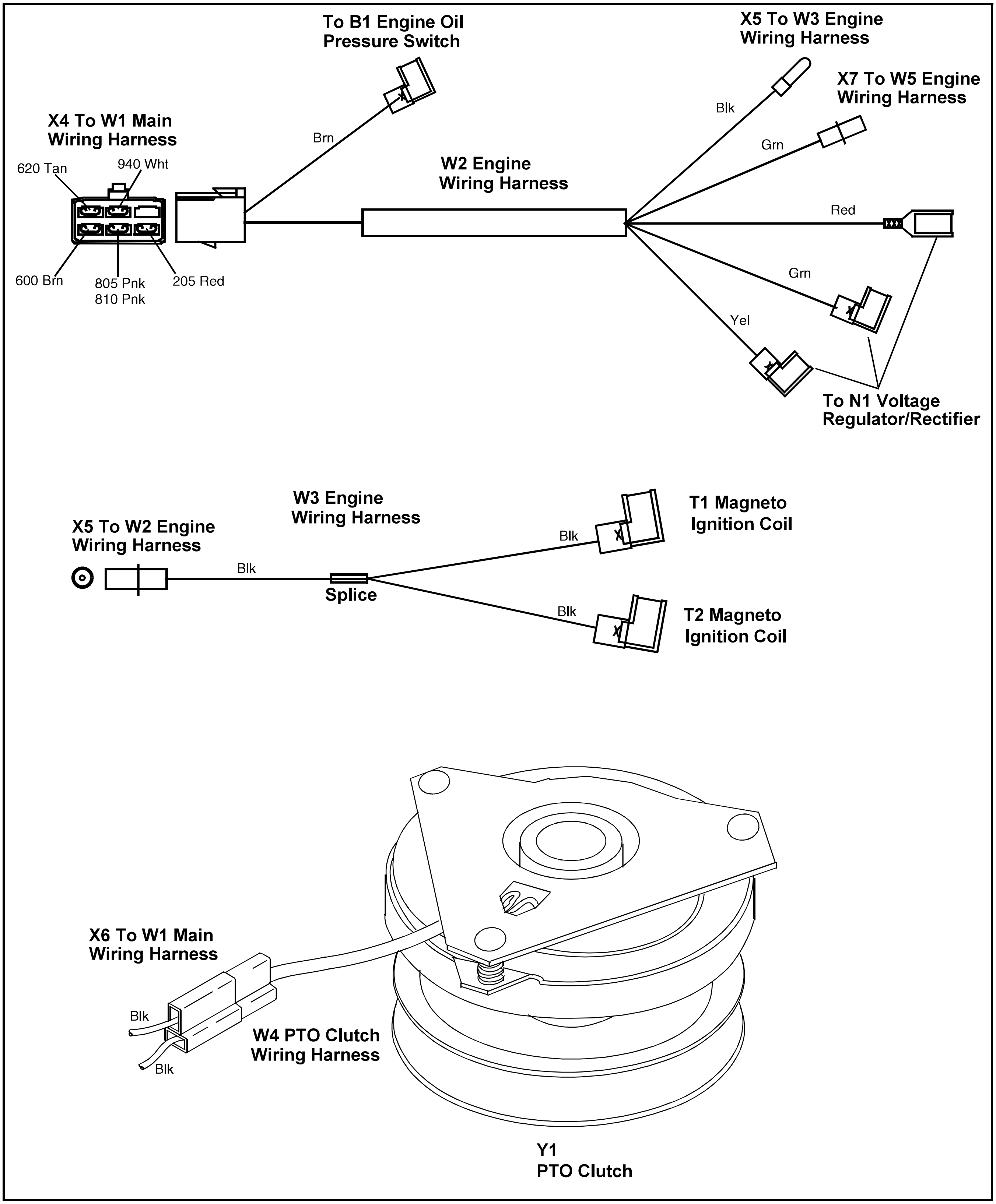

W6 Voltage
Regulator/Rectifier
Ground Wire
To N1 Voltage
Regulator/Rectifier
Blk
To Engine
Ground

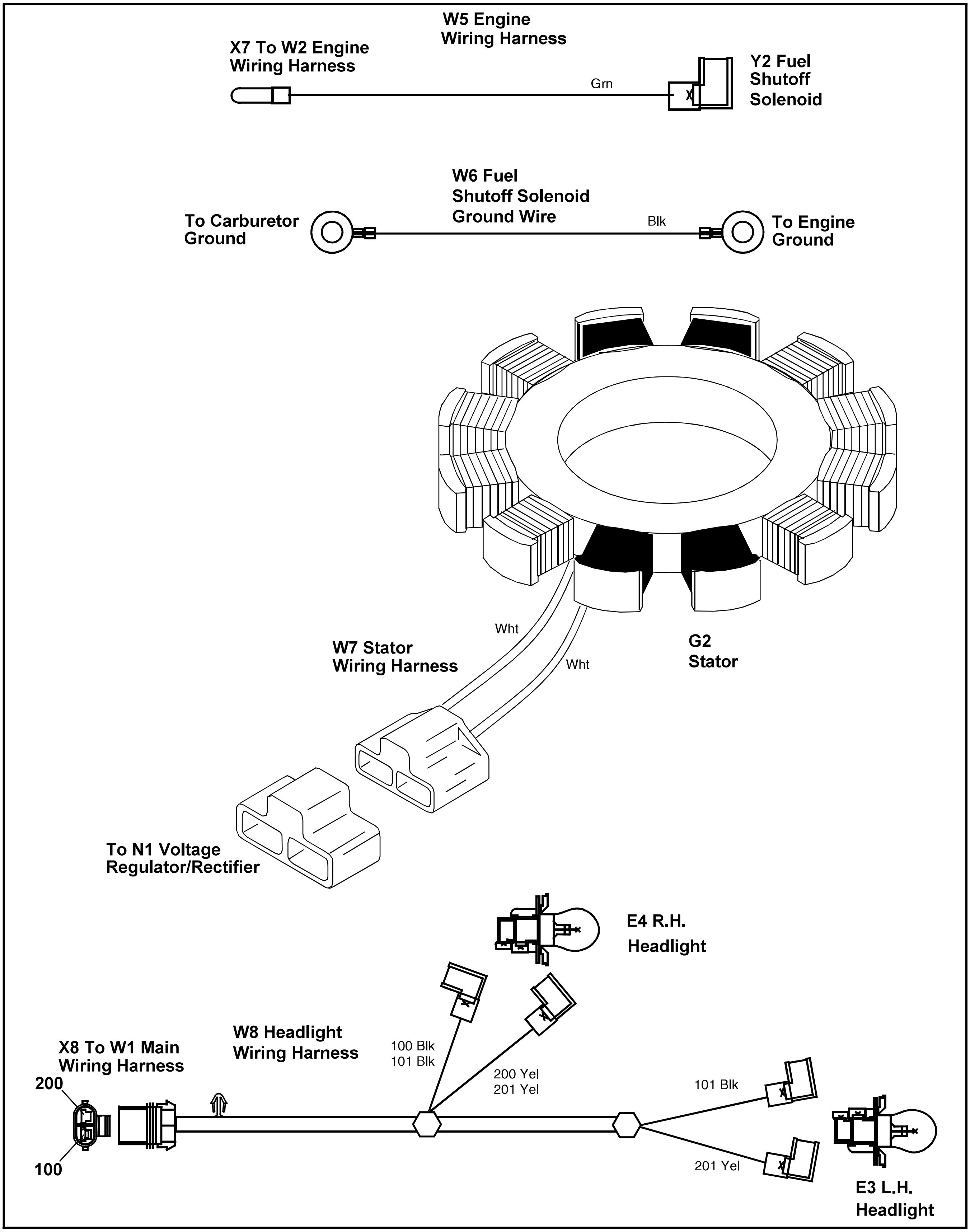

E3 R.H.
Headlight
W7 Headlight
Wiring Harness
X9 To W1 Main
Wiring Harness
200
100
100 Blk
101 Blk
200 Yel
201 Yel
101 Blk
201 Yel
E2 L.H.
Headlight


X7 To W3 Kohler
Engine Wiring Harness
Red
Y2 Fuel
Solenoid

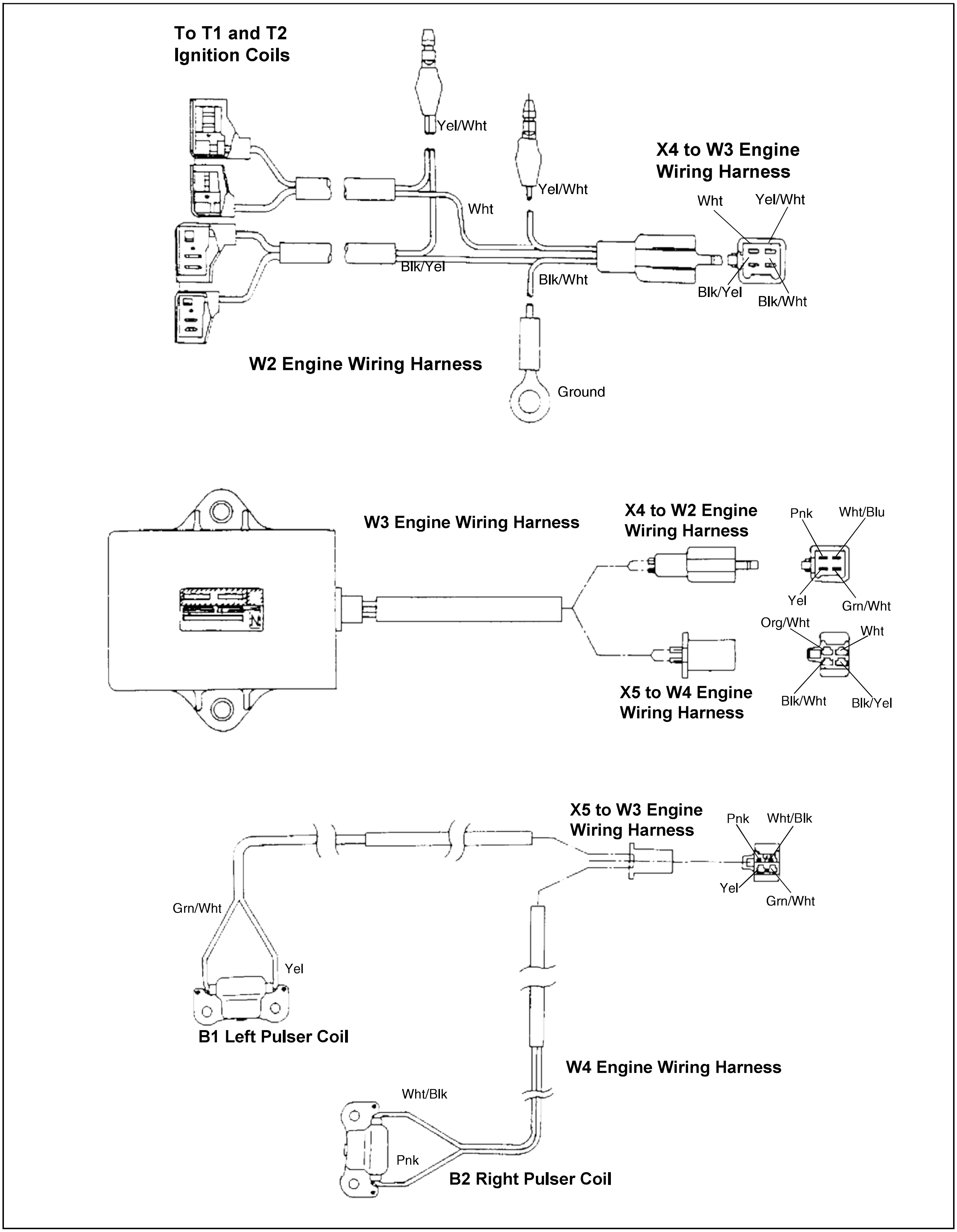

A2 Discharge Module
600 Brn
100 Blk
810 Pnk
X8 to W2
Main Wiring Harness

LX277 and LX288 (FH500V and FH580V) Engine Wiring Harness


To B1 Engine Oil Pressure Switch
X5 To W3 Engine Wiring Harness
X7 To W5 Engine Wiring Harness
X4 To W1 Main Wiring Harness
Brn
Blk
Grn
620 Tan
940 Wht
W2 Engine Wiring Harness
Red
600 Brn
805 Pnk
810 Pnk
205 Red
Grn
Yel
To N1 Voltage Regulator/Rectifier
W3 Engine Wiring Harness
T1 Magneto Ignition Coil
X5 To W2 Engine Wiring Harness
Blk
Blk
Splice
Blk
T2 Magneto Ignition Coil
X6 To W1 Main Wiring Harness
Blk
W4 PTO Clutch Wiring Harness
Blk
Y1
PTO Clutch

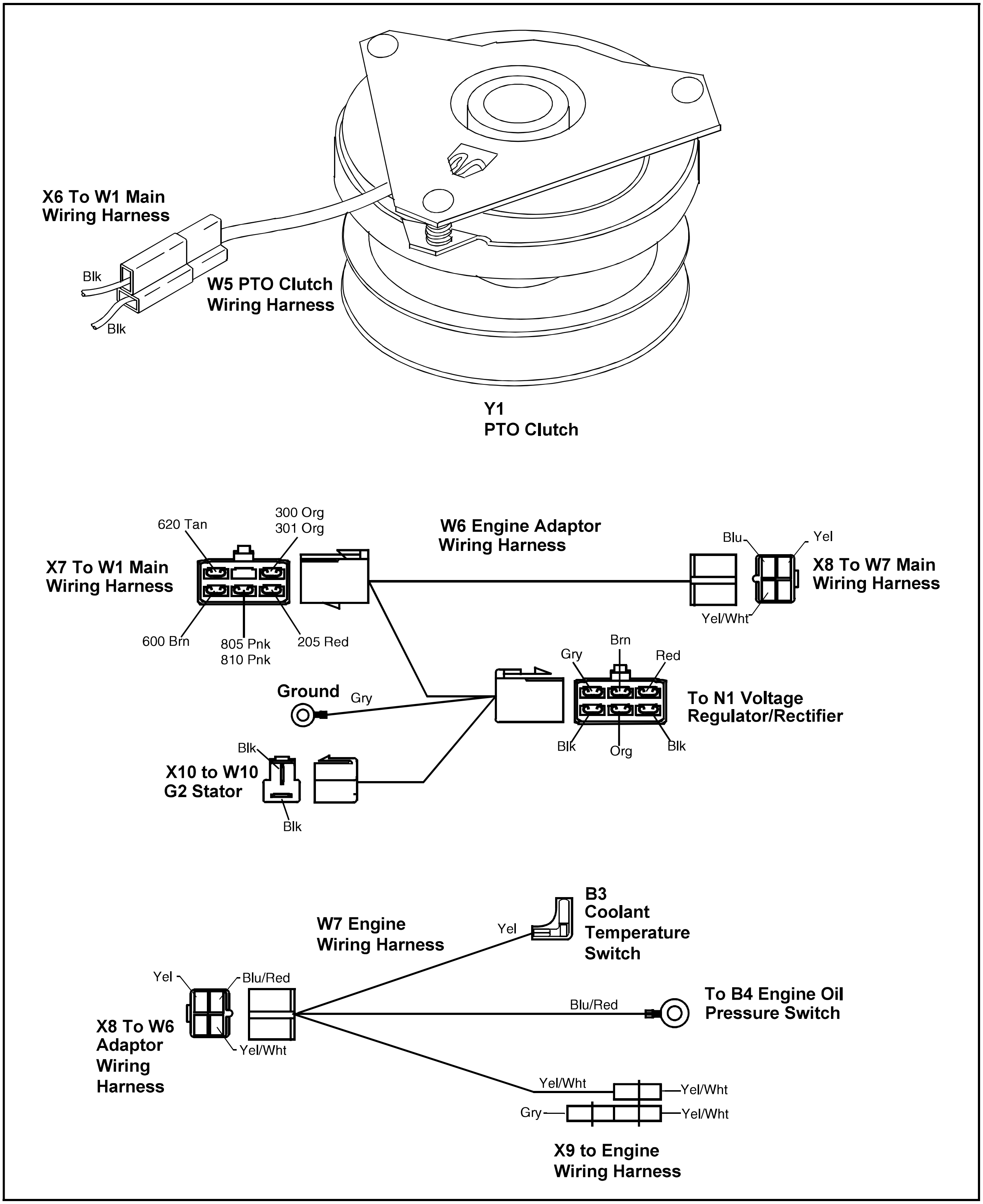

W5 Engine Wiring Harness
X7 To W2 Engine Wiring Harness
Grn
Y2 Fuel Shutoff Solenoid
W6 Fuel Shutoff Solenoid Ground Wire
To Carburetor Ground
Blk
To Engine Ground
Wht
W7 Stator Wiring Harness
Wht
G2 Stator
To N1 Voltage Regulator/Rectifier
E4 R.H. Headlight
W8 Headlight Wiring Harness
X8 To W1 Main Wiring Harness
200
100
100 Blk
101 Blk
200 Yel
201 Yel
101 Blk
201 Yel
E3 L.H. Headlight

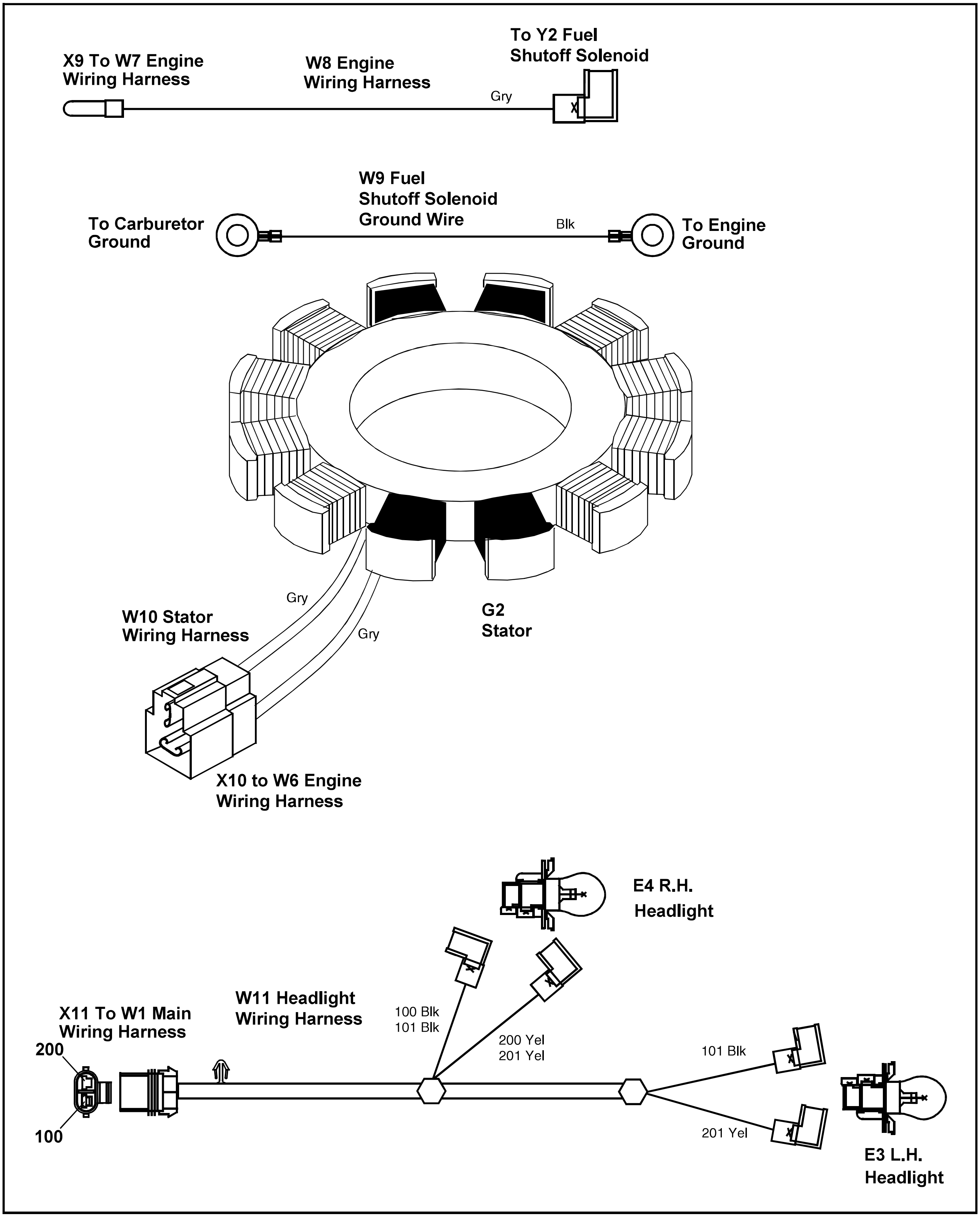
LX279 FD501V Engine Wiring Harness


To T1 and T2
Ignition Coils
Yel/Wht
Yel/Wht
Wht
X4 to W3 Engine
Wiring Harness
Wht
Yel/Wht
Blk/Yel
Blk/Wht
Blk/Yel
Blk/Wht
W2 Engine Wiring Harness
Ground
W3 Engine Wiring Harness
X4 to W2 Engine
Wiring Harness
Pnk
Wht/Blu
Yel
Grn/Wht
Org/Wht
Wht
X5 to W4 Engine
Wiring Harness
Blk/Wht
Blk/Yel
X5 to W3 Engine
Wiring Harness
Pnk
Wht/Blk
Yel
Grn/Wht
Grn/Wht
Yel
B1 Left Pulser Coil
W4 Engine Wiring Harness
Wht/Blk
Pnk
B2 Right Pulser Coil

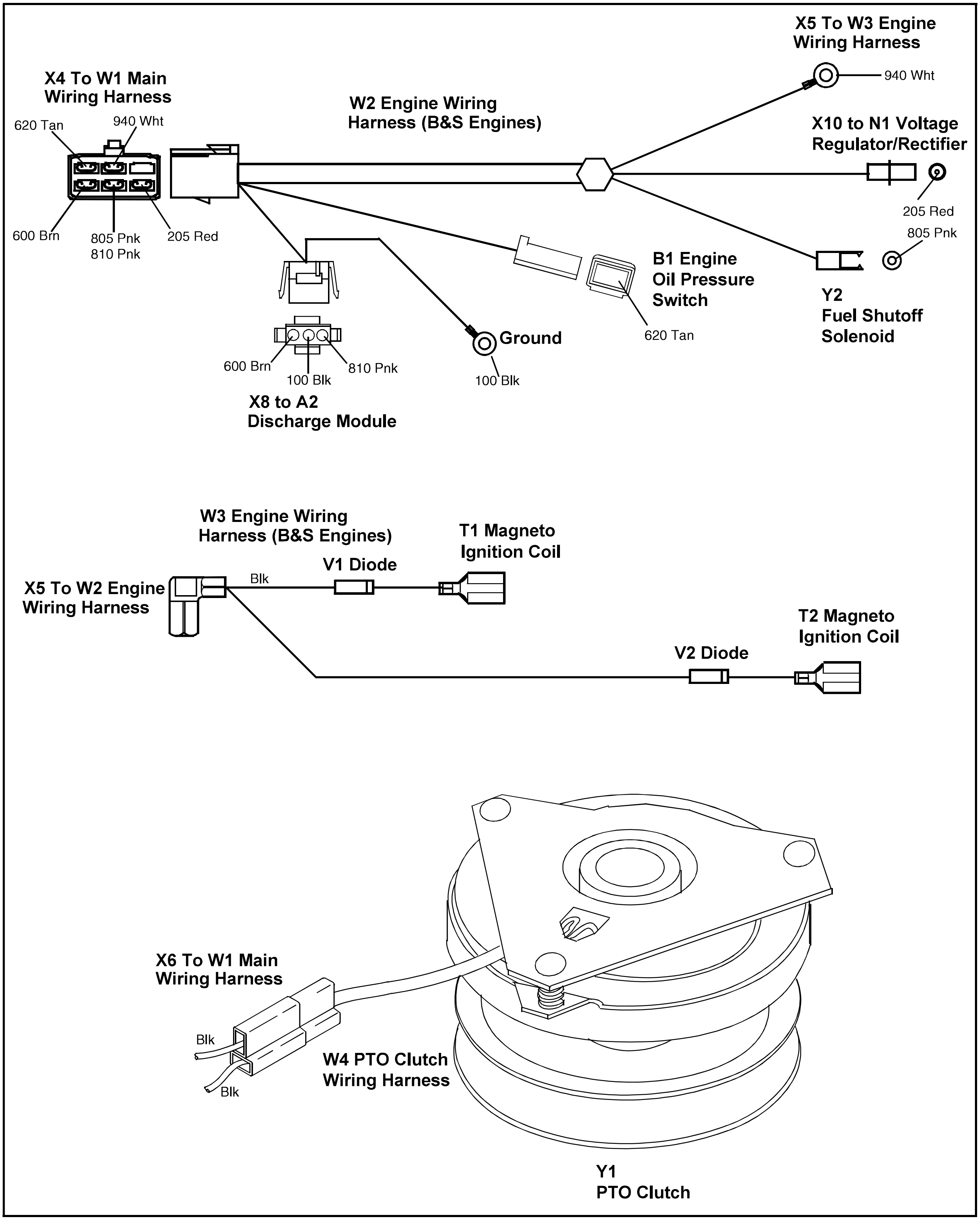
M72547, M72548, M72549

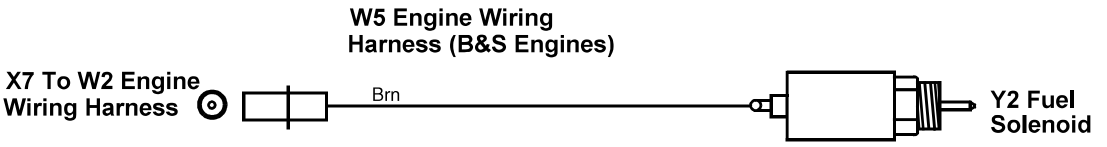
LX279 FD501V Engine Wiring Harness

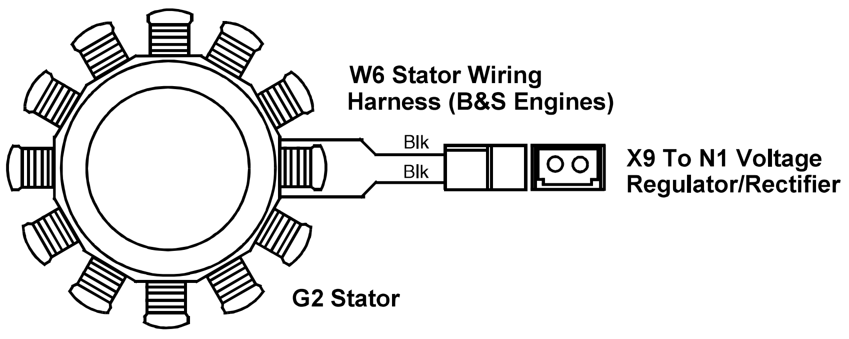

X6 To W1 Main Wiring Harness
Blk
Blk
W5 PTO Clutch Wiring Harness
Y1
PTO Clutch
620 Tan
300 Org
301 Org
X7 To W1 Main Wiring Harness
600 Brn
805 Pnk
810 Pnk
205 Red
W6 Engine Adaptor Wiring Harness
Blu
Yel
X8 To W7 Main Wiring Harness
Yel/Wht
Brn
Gry
Red
Ground
Gry
To N1 Voltage Regulator/Rectifier
Blk
Org
Blk
Blk
X10 to W10 G2 Stator
Blk
B3
Coolant Temperature Switch
W7 Engine Wiring Harness
Yel
Yel
Blu/Red
X8 To W6 Adaptor Wiring Harness
Yel/Wht
Blu/Red
To B4 Engine Oil Pressure Switch
Yel/Wht
Yel/Wht
Gry
Yel/Wht
X9 to Engine Wiring Harness

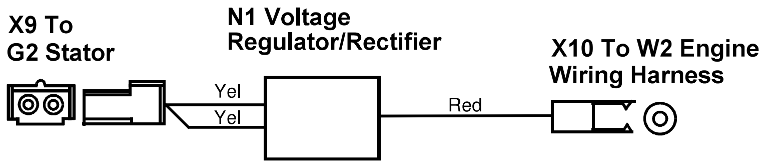

X9 To W7 Engine Wiring Harness
W8 Engine Wiring Harness
To Y2 Fuel Shutoff Solenoid
Gry
W9 Fuel Shutoff Solenoid Ground Wire
To Carburetor Ground
Blk
To Engine Ground
Gry
W10 Stator Wiring Harness
Gry
G2 Stator
X10 to W6 Engine Wiring Harness
E4 R.H. Headlight
X11 To W1 Main Wiring Harness
W11 Headlight Wiring Harness
100 Blk
101 Blk
200 Yel
201 Yel
200
100
101 Blk
201 Yel
E3 L.H. Headlight

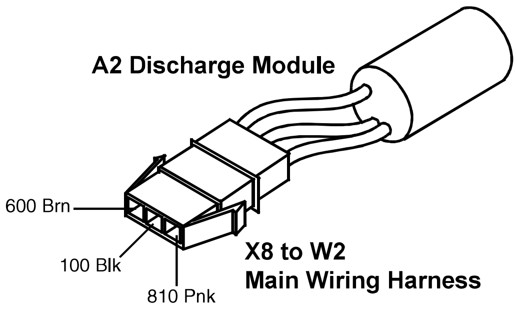
LX288 (SN -090000) B&S Engine Wiring Harness

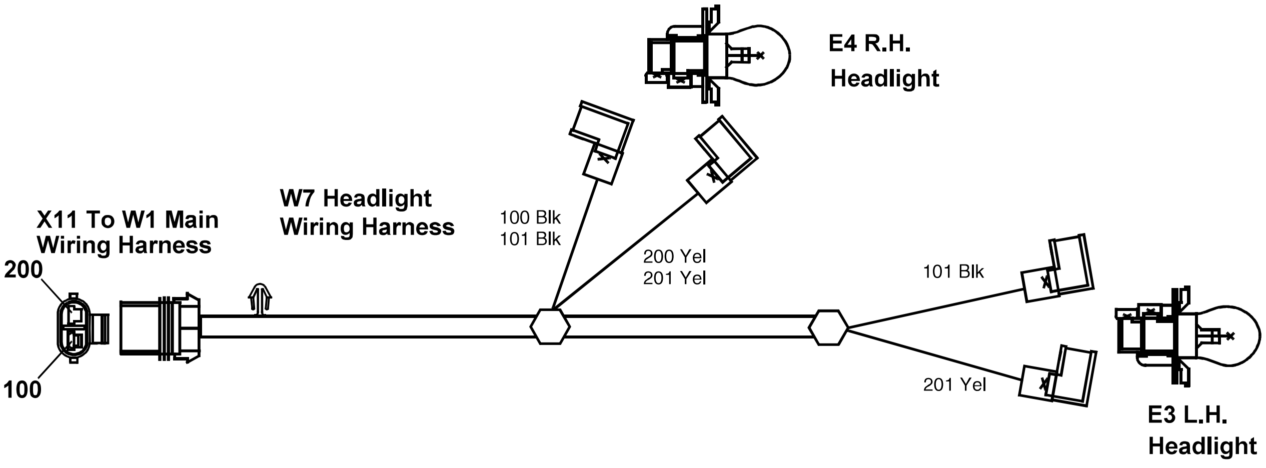

X5 To W3 Engine Wiring Harness
940 Wht
X4 To W1 Main Wiring Harness
620 Tan
940 Wht
W2 Engine Wiring Harness (B&S Engines)
X10 to N1 Voltage Regulator/Rectifier
205 Red
805 Pnk
600 Brn
805 Pnk
810 Pnk
205 Red
B1 Engine Oil Pressure Switch
Y2 Fuel Shutoff Solenoid
Ground
620 Tan
600 Brn
100 Blk
810 Pnk
100 Blk
X8 to A2 Discharge Module
W3 Engine Wiring Harness (B&S Engines)
T1 Magneto Ignition Coil
V1 Diode
X5 To W2 Engine Wiring Harness
Blk
T2 Magneto Ignition Coil
V2 Diode
X6 To W1 Main Wiring Harness
Blk
W4 PTO Clutch Wiring Harness
Blk
Y1 PTO Clutch


W5 Engine Wiring Harness (B&S Engines)
X7 To W2 Engine Wiring Harness
Brn
Y2 Fuel Solenoid


W6 Stator Wiring Harness (B&S Engines)
Blk
Blk
X9 To N1 Voltage Regulator/Rectifier
G2 Stator


X9 To G2 Stator
N1 Voltage Regulator/Rectifier
Yel
Yel
Red
X10 To W2 Engine Wiring Harness


A2 Discharge Module
600 Brn
100 Blk
810 Pnk
X8 to W2 Main Wiring Harness


E4 R.H. Headlight
X11 To W1 Main Wiring Harness
W7 Headlight Wiring Harness
200
100
100 Blk
101 Blk
200 Yel
201 Yel
101 Blk
201 Yel
E3 L.H. Headlight

Theory of Operation

Power Circuit Operation

Function:

Provides unswitched power to the primary machine operating components whenever the battery is connected. In addition to the fuses, this circuit is also protected by the fusible link.

Operating Conditions, Unswitched Circuits:

Voltage should be present at the following locations with the key switch in the “OFF” position:

- Battery positive terminal.
- Battery terminal of starter solenoid bolt.
- “B” Terminal of Key Switch S1.
- Red wire/terminal of Voltage Regulator/Rectifier N1.

The positive battery cable connects the battery to the starter solenoid. The starter solenoid to starter bolt is used as a tie point for the rest of the electrical system.

The battery cables and the starter tie point connections must be good working condition in order for the electrical system to function properly.

The ground cable connections are equally important as the positive connections. Proper starter operation depends on good cables and connections in order to carry the high current load.

The circuit between the starter and the key switch is protected by a fusible link. This link is a short length of wire that is designed to protect the main wiring harness and will fail if current load becomes excessive.

Switched Power Circuit

Function:

Provides switched power to the primary machine operating components by means of the key switch. In addition to the fuses, this circuit is also protected by the fusible link.

Operating Conditions, Switched Power:

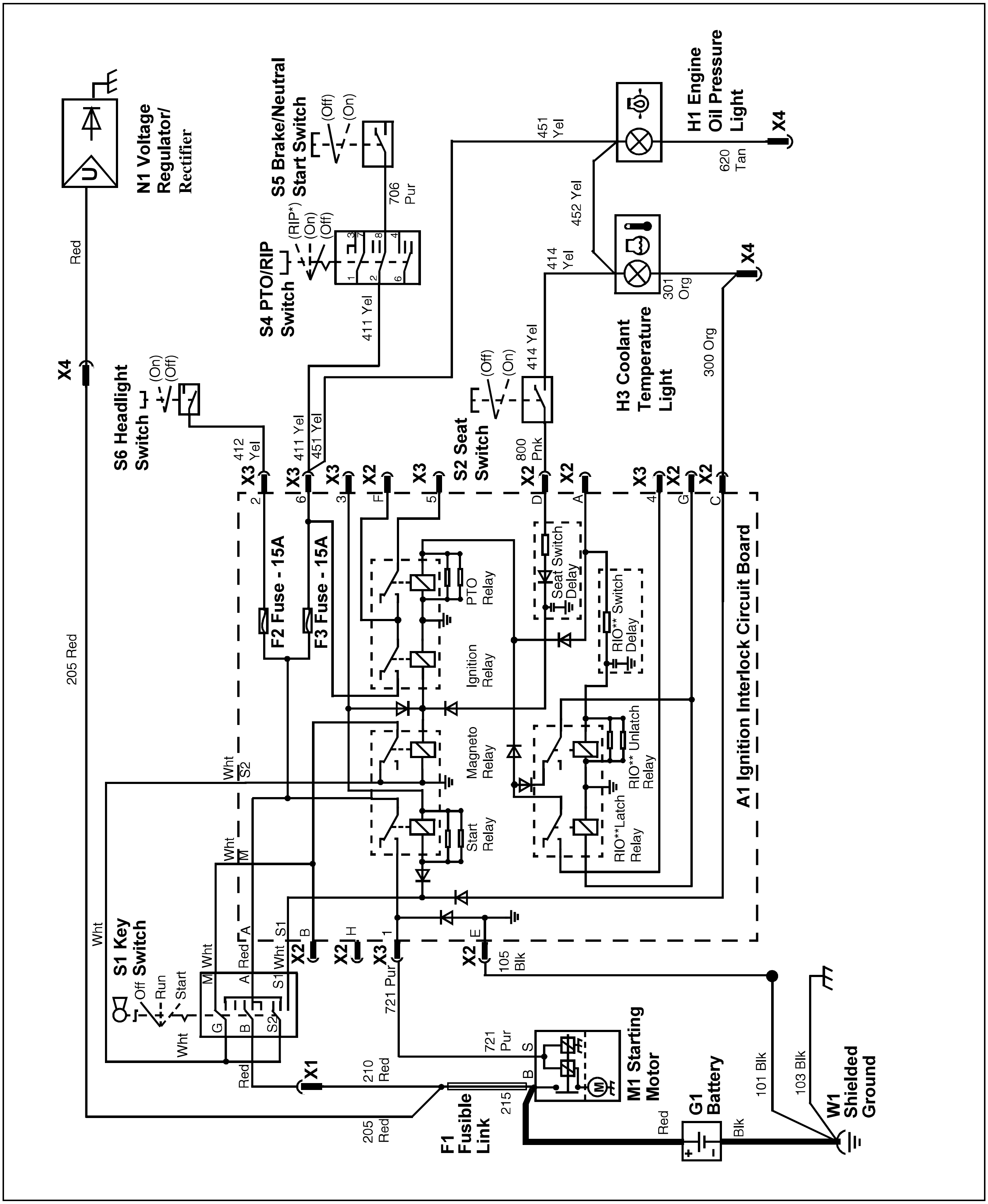
In addition to the voltage present for the unswitched circuit, voltage should be present at the following locations with the key switch in the “RUN” position, the PTO/RIP switch "OFF", the brake/neutral start switch "OFF", and the operator "OFF" the seat:

- S1 Key Switch - Terminal “A”.
- A1 Interlock Module - Solder Joint “A”.
- A1 Interlock Module - Start Relay common terminal.
- A1 Interlock Module - F2 and F3 fuse terminals.
- A1 Interlock Module - Ignition Relay normally open terminal.
- A1 Interlock Module- Terminals “X3-2” and “X3-6”.
- S6 Headlight Switch - Yel wire/terminal.
- S4 PTO/RIP Switch - 411 Yel and 706 Pur wire.
- S5 Brake/Neutral Start Switch - 706 Pur wire.
- H1 Engine Oil Pressure Light - 451 Yel wire.
- H3 Coolant Temperature Light (if equipped) - 452 Yel wire.
- S2 Seat Switch - 414 Yel wire.

With power now available at various locations on the machine, the electrical system is ready to perform the different functions of starting and running the engine, engine monitoring lights, the PTO clutch and the PTO system interlocks, and the headlights.

Grounding for these systems is provided by the 101, 103, 104, and 105 Blk wires. The ground circuit is equally important as the power circuit connections. Proper systems operation depends on good wires and connections in order to carry the current needed to operate the various relays and solenoids and lights.

Power Circuit Schematic


N1 Voltage Regulator/ Rectifier
Red
X4
205 Red
S6 Headlight Switch
(On)
(Off)
412 Yel
S4 PTO/RIP Switch
(RIP*)
(On)
(Off)
411 Yel
S5 Brake/Neutral Start Switch
(Off)
(On)
706 Pur
451 Yel
411 Yel
451 Yel
H1 Engine Oil Pressure Light
620 Tan
X4
452 Yel
414 Yel
H3 Coolant Temperature Light
301 Org
300 Org
X4
S2 Seat Switch
(Off)
(On)
414 Yel
800 Pnk
X3 2
X3 6
X3 3
X2 F
X3 5
X2 D
X2 A
X3 4
X2 G
X2 C
F2 Fuse - 15A
F3 Fuse - 15A
PTO Relay
Ignition Relay
Magneto Relay
Start Relay
Seat Switch Delay
RIO** Switch Delay
RIO** Unlatch Relay
RIO**Latch Relay
A1 Ignition Interlock Circuit Board
Wht S2
Wht M
A
S1
S1 Key Switch
Off
Run
Start
G B S2
M A S1
Wht
Red
X2 B
X2 H
X3 1
X2 E
105 Blk
721 Pur
721 Pur
S
B
M1 Starting Motor
210 Red
X1
Red
215
F1 Fusible Link
205 Red
G1 Battery
Red
Blk
101 Blk
103 Blk
W1 Shielded Ground

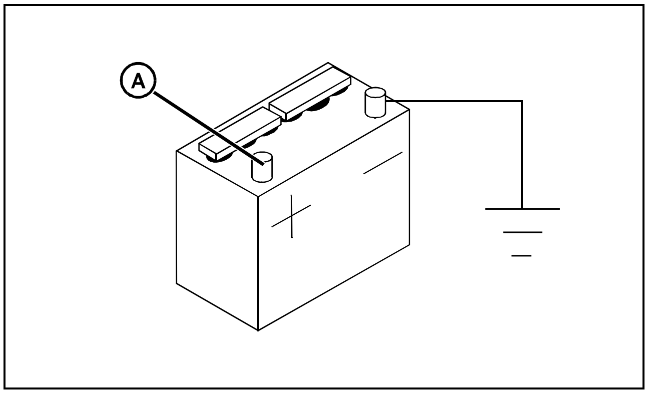
Power Circuit Diagnosis

Procedure A

Test Conditions:

- Key switch in OFF position.

System: Power Circuit

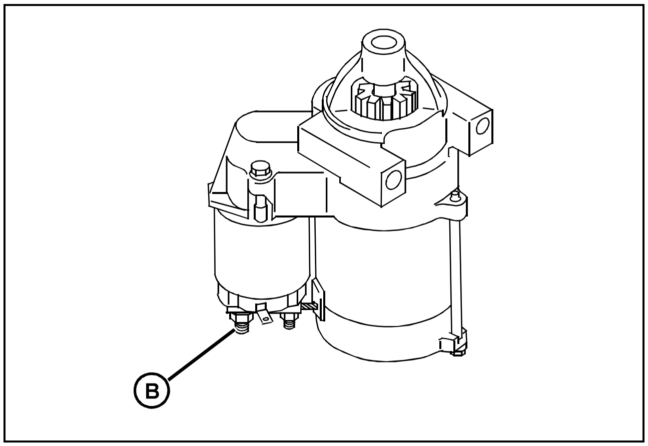


MIF

(1) Is voltage measures at battery positive (+) terminal (A) 12.4 volts or higher?

Yes - Go to next step.

No - Test battery. Charge is necessary. See “Battery - Charge” on page 331.



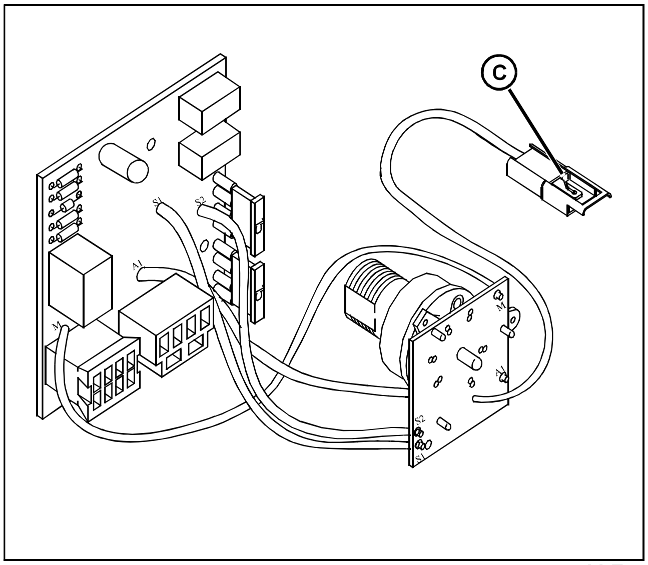
MIF

(2) Is battery voltage present between starter solenoid battery terminal (B) and ground?

Yes - Go to next step.

No - Check battery cables and connections.

System: Power Circuit



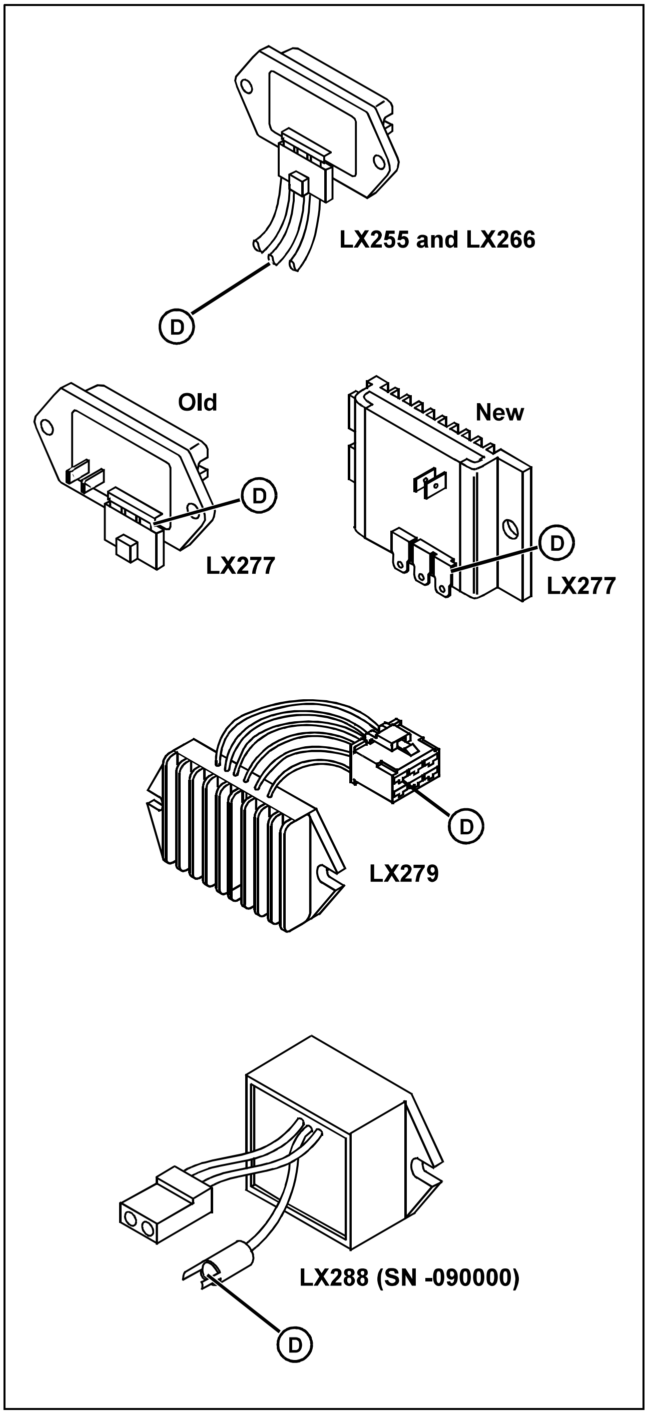
MIF

(3) Is battery voltage present between S1 Key Switch Connector X1 (C) and ground?

Yes - Go to next step.

No - Check F1 fusible link, 210 Red wire, X1 connector to key switch and connections.

System: Power Circuit



MIF

(4) Is battery voltage present at voltage regulator/ rectifier 205 Red wire (D)?

Yes - Go to next procedure.

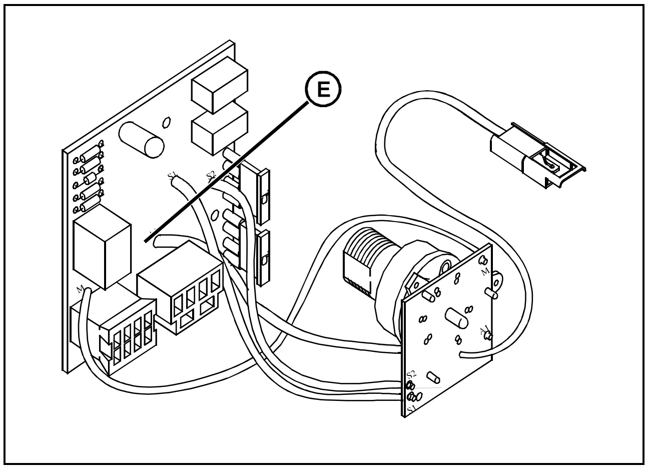
No - Check 205 Red wire and connections.

Procedure B

Test Conditions:

- Key switch in RUN position - Engine NOT running.
- PTO OFF.
- Brake/Neutral start switch OFF.
- Seat switch OFF.
- Headlights OFF.

System: Power Circuit

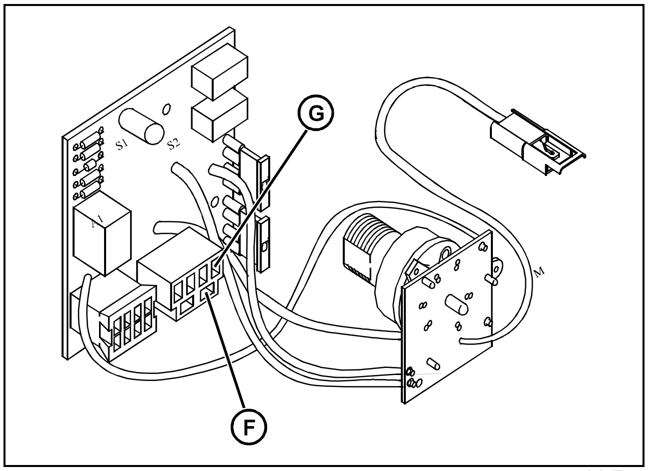


MIF

(1) Is battery voltage present at A1 Interlock Module - Red solder connection “A” (E)?

Yes - Go to next step.

No - Check Red wire from key switch. If OK, replace key switch.



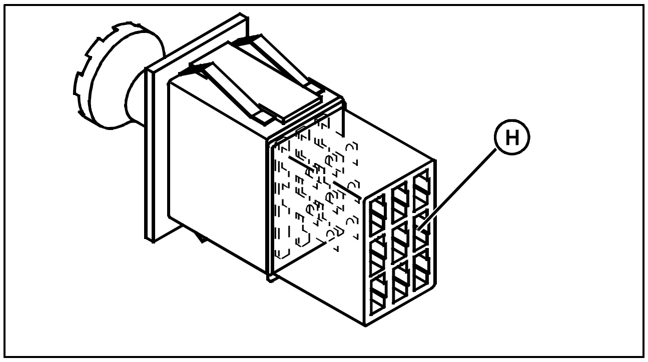
MIF

(2) Is battery voltage present at interlock module - terminal X3, pins 2 (F) and 6 (G)?

Yes - Go to next step.

System: Power Circuit

No - Check fuse F2 and F3. If OK, replace interlock module.

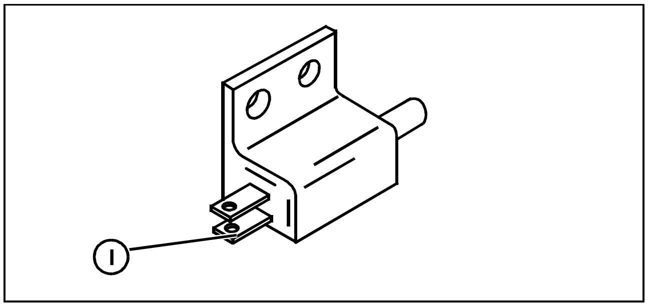


MIF

(3) Is voltage present at 411 Yel wire (H) at PTO/RIP switch?

Yes - Go to next step.

No - Check 411 Yel wire and connections.

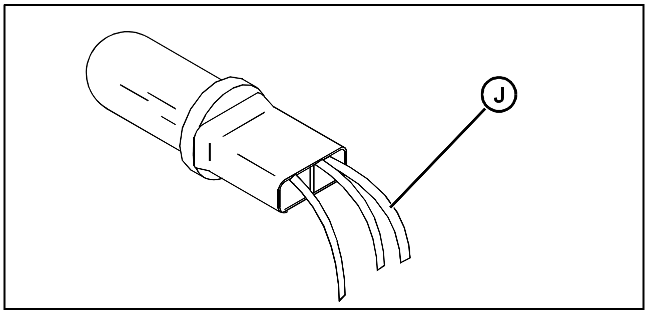


MIF

(4) Is battery voltage present at S5 Brake/Neutral start switch 706 Pur wire (I)?

Yes - Go to next step.

No - Check 706 Pur wire and connections. If OK, replace PTO/RIP switch.

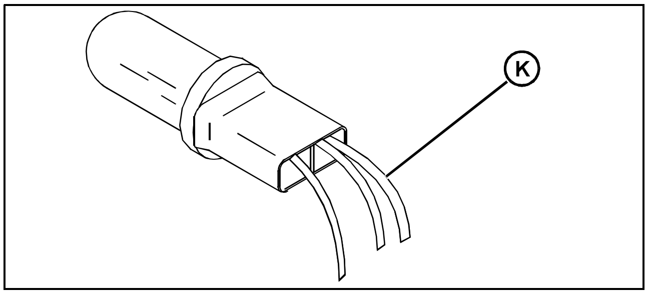


(5) Is battery voltage present at H1 Oil Pressure Light 451 Yel wire (J)?

Yes - Go to next step.

System: Power Circuit

No - Check 451 Yel wire and connections.

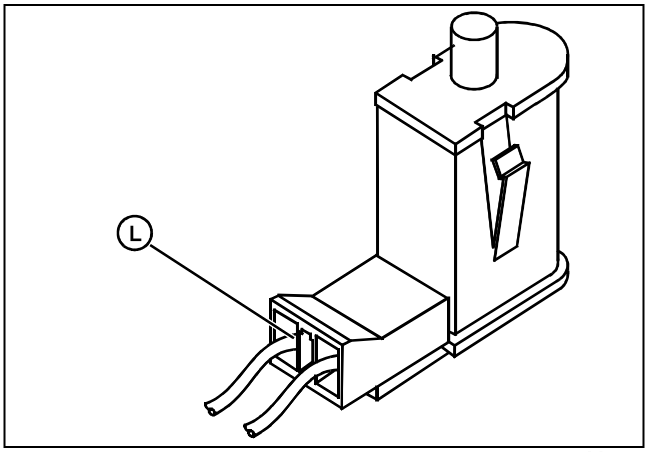


MIF

(6) Is battery voltage present at H3 Coolant Temperature Light 452 Yel wire (K)?

Yes - Go to next step.

No - Check 452 Yel wire and connections.

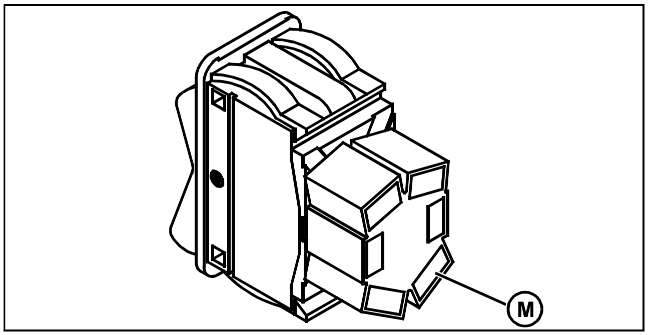


MIF

(7) Is battery voltage present at S2 Seat Switch 414 Yel wire (L)?

Yes - Go to next step.

No - Check 414 Yel wire and connections.



MIF

(8) Is battery voltage present at S6 Headlight Switch 412 Yel wire (M)?

No - Check 412 Yel wire and connections.

Cranking Circuit Operation

Function:

The cranking system is used to energize the starting motor which in turn is used to start the engine.

Operating Conditions:

- Key Switch in START position.
- Brake/Neutral start switch in NEUTRAL position (Parking brake locked.).
- PTO/RIP switch in OFF position.

NOTE: The operator does not have to be in the seat (seat switch closed) to crank engine.

System Operation:

NOTE: The key switch is connected to the printed circuit board (A1 Interlock Module) by soldered wire connections. Components are solid state and are not serviced separately except for the 15 amp fuses. Lines within dashed border of the Interlock Module (A1) except for key switch connections are circuit paths on the circuit board are not wires in the harness.

The starting motor is a solenoid shift design. The power circuit provides current to the key switch (S1) and protects the cranking circuit with a fusible link (F1). Current flows from the battery (G1) positive (+) terminal to the starter solenoid battery terminal, fusible link (F1), 210 Red wire, X1 connector, Red wire and key switch. With the key switch in the START position, current flows through the Red wire to the interlock module (A1) and to the start relay common terminal and the 15 amp fuse (F3). From the 15 amp fuse (F3) current flows to the ignition relay normally open terminal and the 411 Yel wire. The 411 Yel wire provides current flow to the PTO/RIP switch (S4), 706 Pur wire, brake/neutral start switch (S5), 711 Pur wire, interlock module (A1) to the ignition relay, magneto relay and the start relay coils. This causes the ignition, magneto, and start relays to be energized and shift from the normally closed position to the normally open position.

The ignition relay provides current to the PTO/RIP switch (S4), fuel shutoff solenoid and voltage regulator/rectifier. At this same time the magneto relay shift away from the normally closed contact and breaks the path to ground allowing the ignition coils to create a spark that will ignite the air fuel mixture.

The start relay is also energized and shifts to the normally open contact allowing current to flow to the 721 Pur wire and the starting motor pull in and hold in coils of the start solenoid.

The start solenoid is engaged by current flowing through both pull-in and hold-in windings, pulling the plunger inward. The plunger closes the solenoid main contacts.

When the main contacts are closed, both ends of the pull-in windings have the same voltage so current through the pull-in windings stops. Current continues through the hold-in windings, keeping the solenoid engaged.

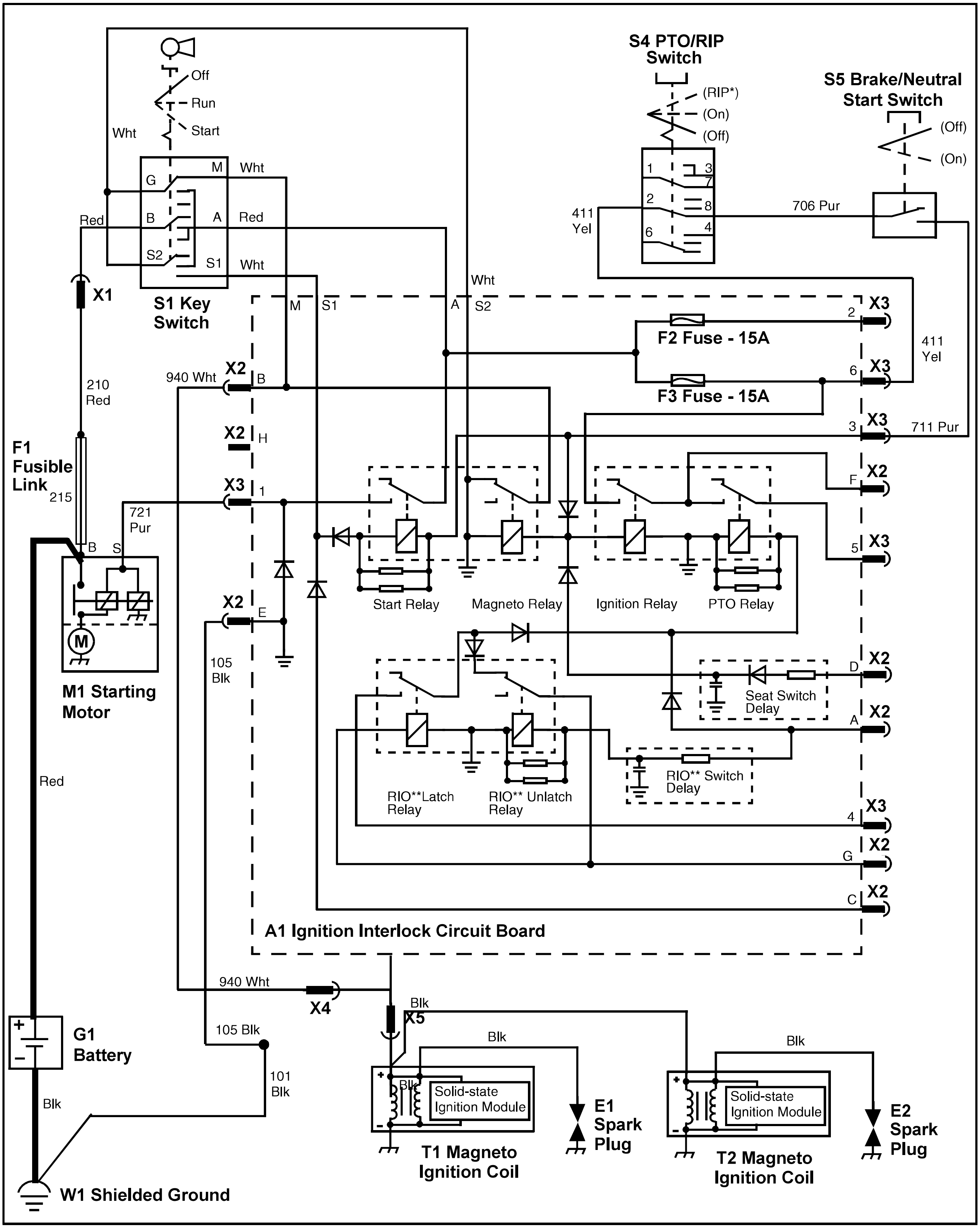
With the solenoid main contacts closed, high current from the battery flows across the main contacts to the starter motor (M1) causing it to turn.

The PTO/RIP switch is used in the neutral start circuit to prevent the engine from cranking if the PTO is engaged. With the PTO/RIP switch off (PTO disengaged), current flows to the brake/neutral start switch (S5).

The brake/neutral start switch is used in the neutral start circuit to prevent the engine from cranking if the transmission is engaged.

The brake/neutral start switch is located on the top of the transmission and is activated by the brake actuator linkage. When the parking brake is locked (transmission is automatically shifted into NEUTRAL), the brake actuator linkage closes the brake/neutral start switch.

Cranking Circuit Schematic


Off
Run
Start
Wht
G
M
Wht
B
A
Red
Red
S2
S1
Wht
X1
S1 Key Switch
S4 PTO/RIP Switch
(RIP*)
(On)
(Off)
S5 Brake/Neutral Start Switch
(Off)
(On)
1
3
7
2
8
6
4
411 Yel
706 Pur
Wht
M
S1
A
S2
X3
2
F2 Fuse - 15A
411 Yel
6
X3
F3 Fuse - 15A
940 Wht
X2
B
210 Red
X2
H
3
X3
711 Pur
F1 Fusible Link
215
X3
1
721 Pur
X2
F
B
S
5
X3
X2
E
Start Relay
Magneto Relay
Ignition Relay
PTO Relay
M1 Starting Motor
105 Blk
D
X2
Seat Switch Delay
A
X2
RIO**Latch Relay
RIO** Unlatch Relay
RIO** Switch Delay
Red
4
X3
G
X2
C
X2
A1 Ignition Interlock Circuit Board
940 Wht
X4
Blk
X5
105 Blk
Blk
Blk
G1 Battery
101 Blk
Blk
Solid-state Ignition Module
E1 Spark Plug
Solid-state Ignition Module
E2 Spark Plug
Blk
T1 Magneto Ignition Coil
T2 Magneto Ignition Coil
W1 Shielded Ground

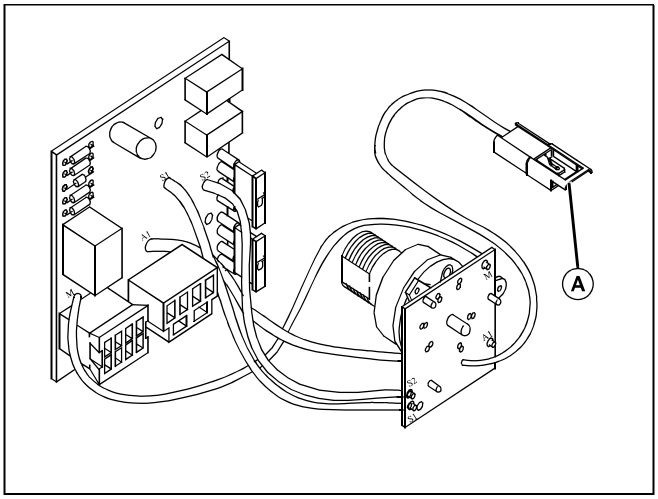
Cranking Circuit Diagnosis

Procedure A

Test Conditions:

- Key switch in RUN position - Engine NOT running.
- PTO OFF.
- Parking brake LOCKED (Brake/Neutral start switch in NEUTRAL position).

System: Cranking Circuit

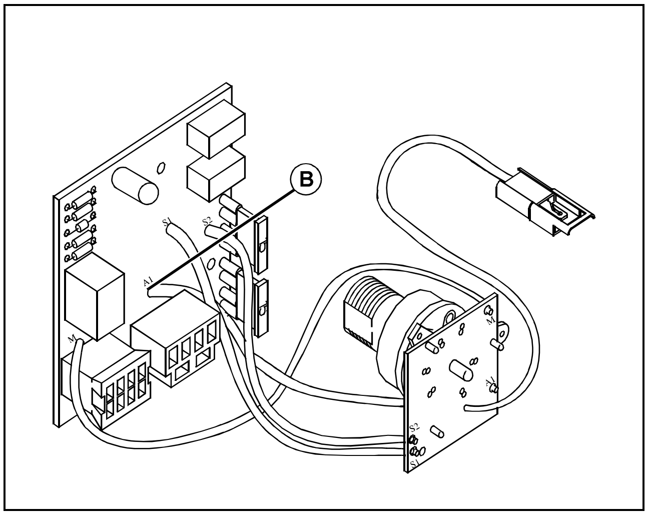


(1) Is battery voltage present at S1 Key Switch X1 connector (A)?

Yes - Go to next step.

No - Check F1 fusible link, 210 Red wire, X1 connector to key switch an connector.

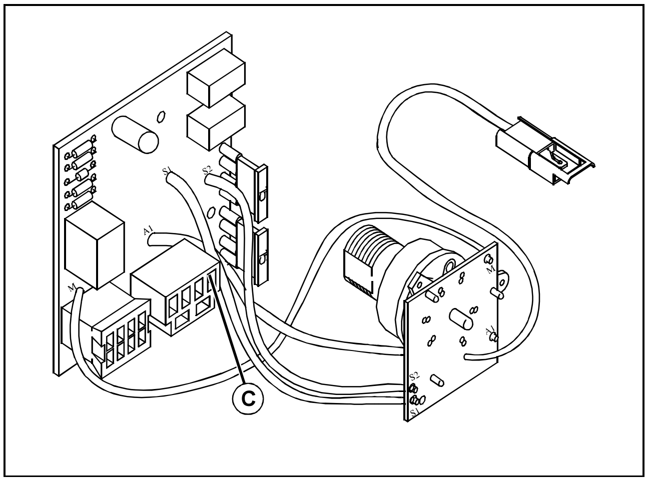
System: Cranking Circuit



(2) Is battery voltage present at A1 Interlock Module, “A” solder joint (B)?

Yes - Go to next step.

No - Check Red wire from key switch. If OK, replace key switch.

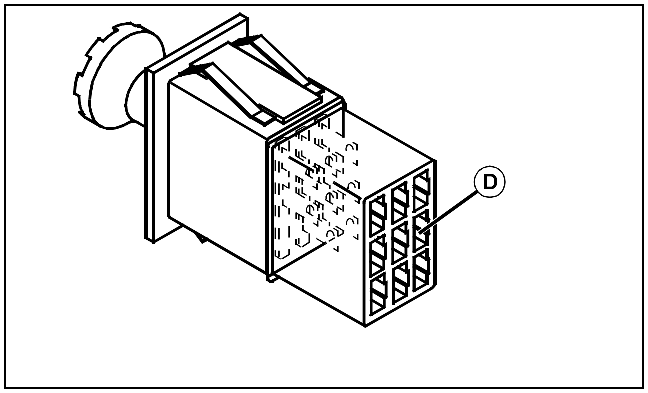


(3) Is battery voltage present A1 Interlock Module, connector X3, pin 6 (C)?

Yes - Go to next step.

No - Check fuse F3. If OK, replace A1 Interlock Module.

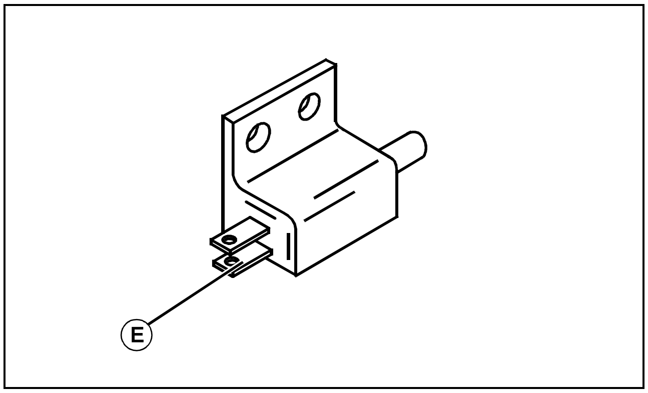
System: Cranking Circuit



(4) Is battery voltage present at S4 PTO/RIP switch 411 Yel wire (D)?

Yes - Go to next step.

No - Check 411 Yel wire and connections.

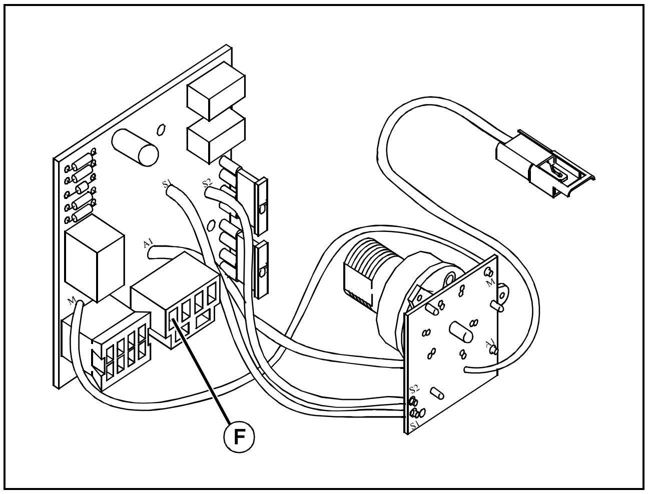


(5) Is battery voltage present at S5 Brake/Neutral Start Switch 706 Pur wire (E)?

Yes - Go to next step.

No - Check 706 Pur wire and connections. If OK, replace PTO/RIP switch.

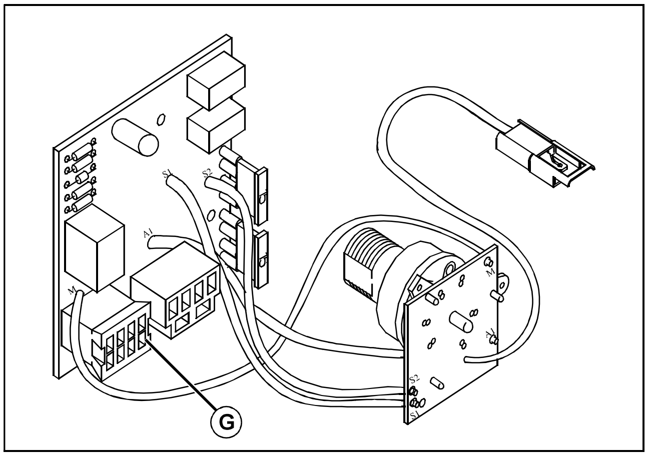
System: Cranking Circuit



(6) Is battery voltage present at A1 Interlock Module connector X3, pin 3 (F)?

Yes - Go to next step.

No - Check 711 Pur wire and connections. If OK, replace interlock module.

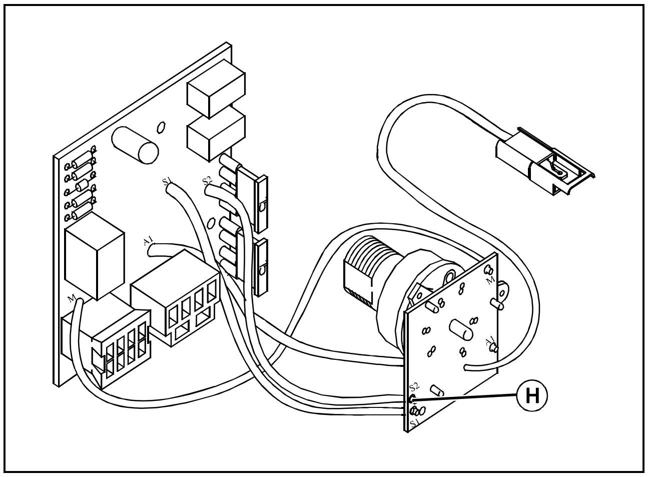


(7) Is there continuity to ground at A1 Interlock Module connector X2, pin E (G)?

Yes - Go to next step.

No - Check 105 and 101 Blk wires and connections.

System: Cranking Circuit



(8) Is there continuity to ground at S1 Key Switch, Wht wire S2 (H)?

Yes - Go to next step.

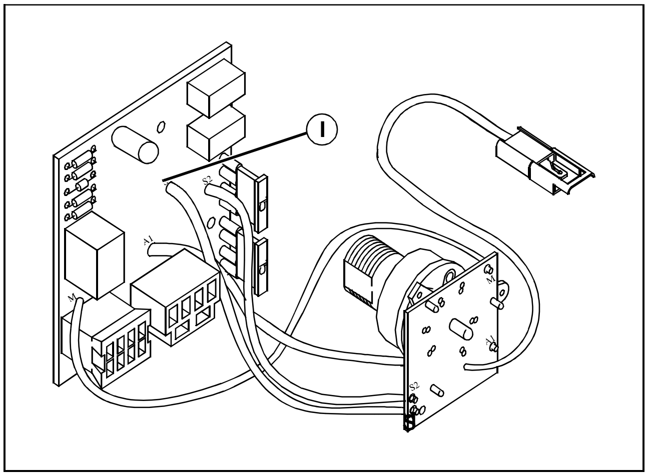
No - Check Wht wire and connections to interlock module. If OK, replace interlock module.

Procedure B

Test Conditions:

- Key switch in START position.
- Spark plug wires disconnected and GROUNDED.
- PTO OFF.
- Park brake LOCKED.

System: Cranking Circuit

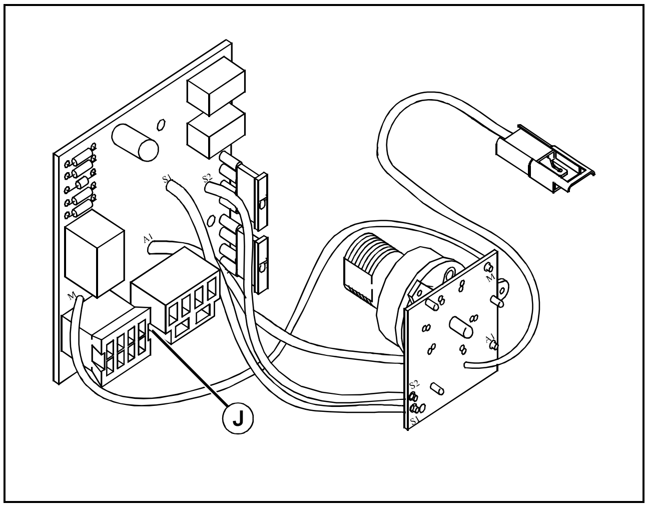


(1) Is there continuity to ground at A1 Interlock Module S1 solder joint (I)?

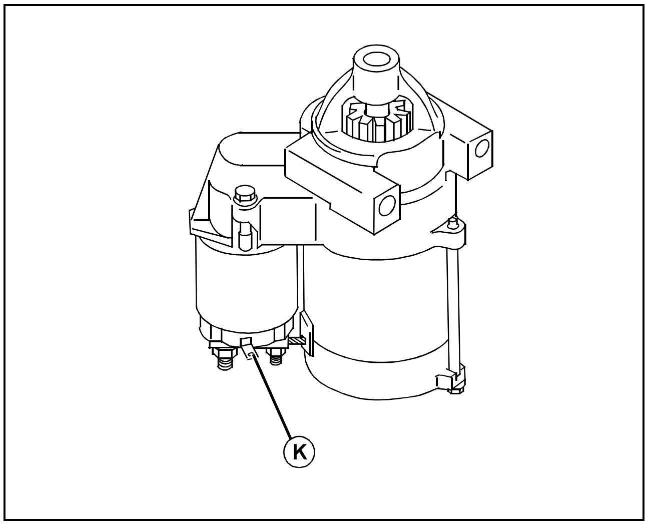
System: Cranking Circuit

Yes - Go to next step.

No - Check Wht wire and connections to S1 Key Switch. If OK, replace key switch.



(2) Is battery voltage present at interlock module connector X3, pin 1 (J)?



(3) Is battery voltage present at starter solenoid 721 Pur wire (K)?

Yes - Go to next step.

No - Check 721 Pur wire and connections.

No - If starter motor is not turning, test starter motor. See “Starting Motor Solenoid Test” on page 335.

Ignition Circuit Operation - LX255, LX266, LX277 and LX288

Function:

To create a spark that ignites the fuel/air mixture in the engine.

Operating Conditions:

- Key switch in START or RUN position.
- Operator ON seat (Seat switch CLOSED).
- PTO/RIP switch in OFF position.
- Parking brake LOCKED or UNLOCKED.

or,

- Key switch in START or RUN position.
- Operator OFF seat (Seat switch OPEN).
- PTO/RIP switch in OFF position.
- Parking brake locked (Brake/Neutral start switch CLOSED.)

System Operation:

NOTE: The key switch is connected to the printed circuit board (A1 Interlock Module) by soldered wire connections. Components are solid state and are not serviced separately except for the 15 amp fuses. Lines within dashed border of the Interlock Module (A1) except for key switch connections are circuit paths on the circuit board are not wires in the harness.

he ignition system is a transistor-controlled magneto design. Ignition timing is controlled by the transistor and is not adjustable. As the engine turns over, (see “Cranking Circuit Operation” on page 277.) the flywheel magnet induces current into the magneto ignition coil, which in turn produces current high enough to jump the spark plug(s) gap, creating spark to ignite the engine fuel/air mixture.

Engine Shutting OFF - LX255, LX266, LX277 and LX288

Function:

To shut the engine off by grounding the ignition coil through the ignition relay.

Operating Conditions:

- Key switch in OFF position.
- Operator OFF seat with PTO engaged.
- Operator OFF seat with transmission engaged.

System Operation:

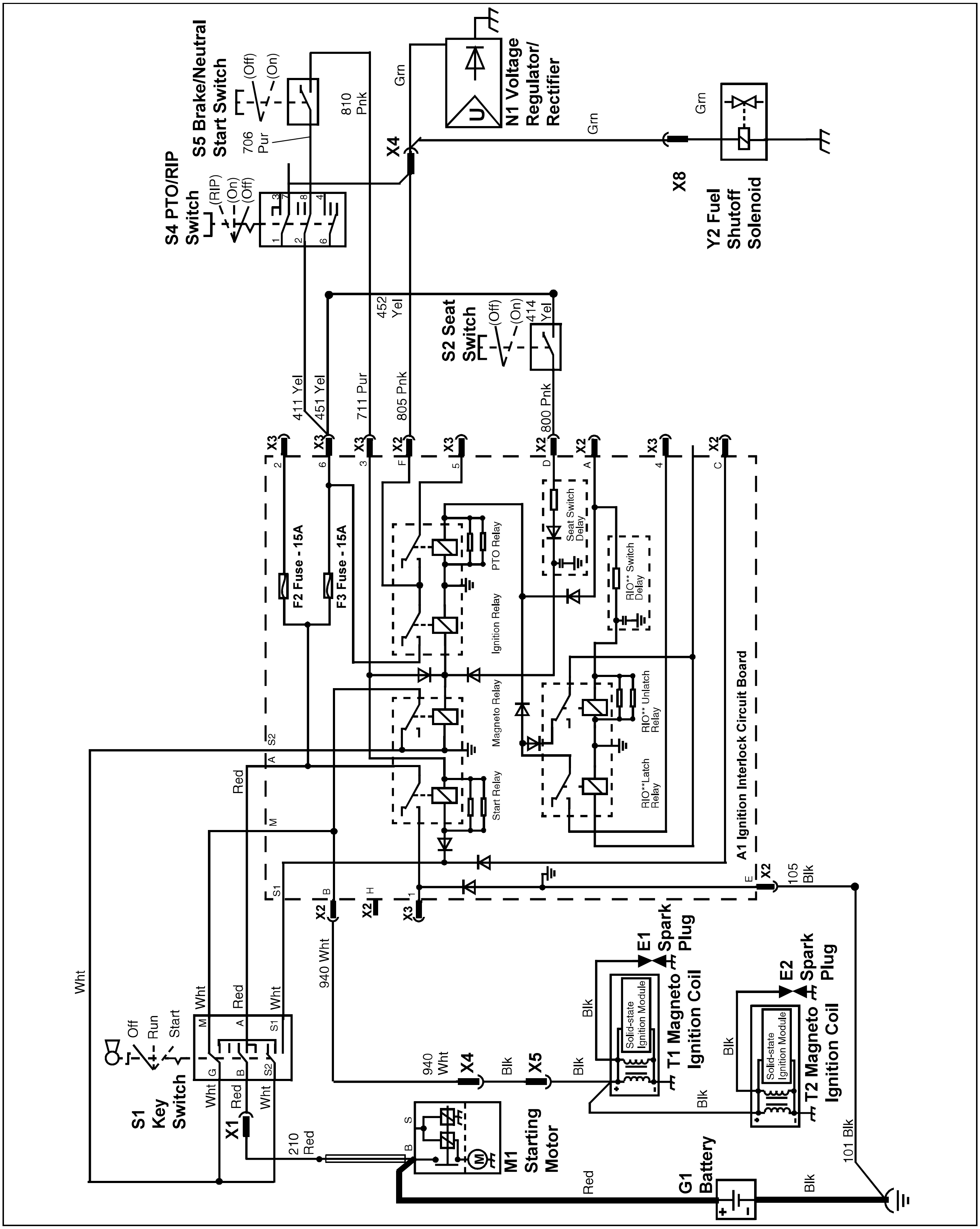
The engine is shut off by grounding the ignition coils (T1) and (T2). With the ignition primary coil grounded, a spark cannot be produced.

When the key switch (S1) is turned to the OFF position, a path to ground is created through the key switch Wht wire (M) solder connection and back to the interlock module through the Wht wire (S2) solder connection. In addition the power circuit current flow is stopped at the key switch. This de-energizes the magneto relay providing a path to ground for ignition coil through the magneto relay.

The magneto relay coil is energized by current from the seat switch circuit or neutral start circuit. If the operator gets off the seat (seat switch opens) with the PTO engaged or with the transmission engaged, current flow to the magneto relay coil is stopped.

The seat switch or brake/neutral start switch also energizes the ignition relay. Whenever the ignition relay is de-energized, the fuel shutoff solenoid is also de-energized and fuel flow to the carburetor is stopped.

Ignition Circuit Schematic - LX255, LX266, LX277 and LX288


S4 PTO/RIP Switch
(RIP)
(On)
(Off)
S5 Brake/Neutral Start Switch
(Off)
(On)
706 Pur
810 Pnk
Grn
N1 Voltage Regulator/ Rectifier
X4
Grn
Grn
X8
Y2 Fuel Shutoff Solenoid
S2 Seat Switch
(Off)
(On)
414 Yel
452 Yel
411 Yel
451 Yel
711 Pur
805 Pnk
800 Pnk
X3
X2
F2 Fuse - 15A
F3 Fuse - 15A
PTO Relay
Ignition Relay
Magneto Relay
Start Relay
Seat Switch Delay
RIO** Switch Delay
RIO** Unlatch Relay
RIO**Latch Relay
A1 Ignition Interlock Circuit Board
105 Blk
Wht
Red
S1 Key Switch
Off
Run
Start
G
B
S2
M
A
S1
Wht
Red
X1
210 Red
940 Wht
X4
X5
Blk
M1 Starting Motor
S
B
E1 Spark Plug
E2 Spark Plug
T1 Magneto Ignition Coil
T2 Magneto Ignition Coil
Solid-state Ignition Module
G1 Battery
101 Blk
Red
Blk

Ignition Circuit Diagnosis - LX255, LX266, LX277 and LX288

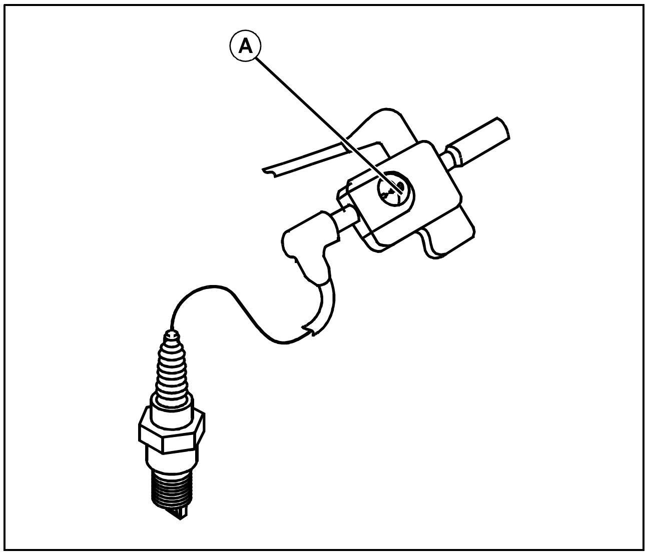
When diagnosing an ignition problem, isolate the magneto circuit from the ground circuit by separating the engine connector (X5). If the engine will not start check the magneto circuit first and then the ground circuit. If the engine will not shut off, check the ground circuit first. Remember the engine is stopped by grounding the ignition coil through either the key switch or ignition relay. The ignition relay must be energized to prevent the ignition coil from being grounded.

Procedure A

Test Conditions:

- Key switch in START position.
- Park brake ON.
- Engine connector X4 DISCONNECTED.
- PTO OFF.

System: Ignition Circuit

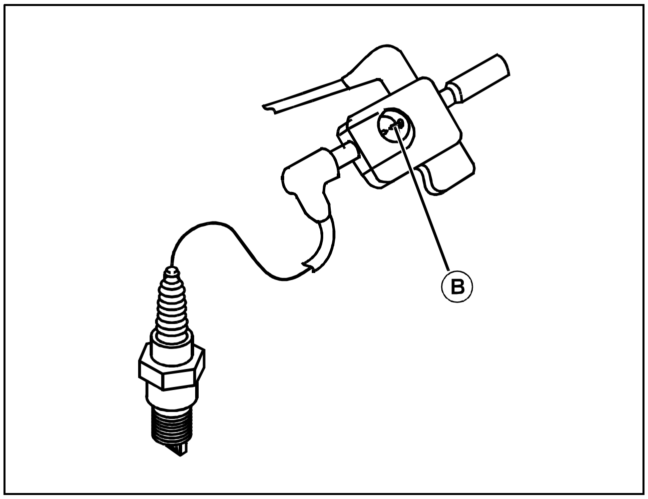


(1) Does spark plug/spark tester indicate a hot, blue spark (A)?

Yes - Go to next step.

No - Test ignition coil and ignition module. Check armature gap and flywheel magnets. See “Armature Air Gap Adjustment” on page 338, “Flywheel Magnet Test” on page 335, “Ignition Coil Test - LX279” on page 339 and “Ignition Module Test - LX279” on page 339.

System: Ignition Circuit



(2) Is a spark present but yellow or weak (B)?

No - Go to next step.

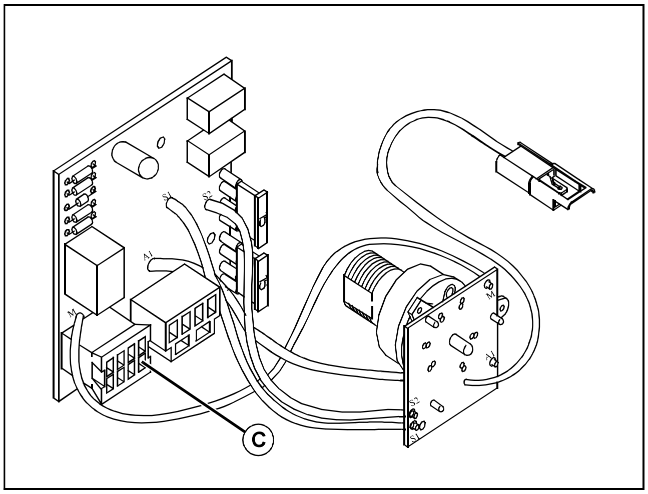
Yes - Check spark plug gap and condition of spark plug. If plug is good, continue with test.

Procedure B

Test Conditions:

- Key switch in OFF position.
- All other functions in OFF position.

System: Ignition Circuit

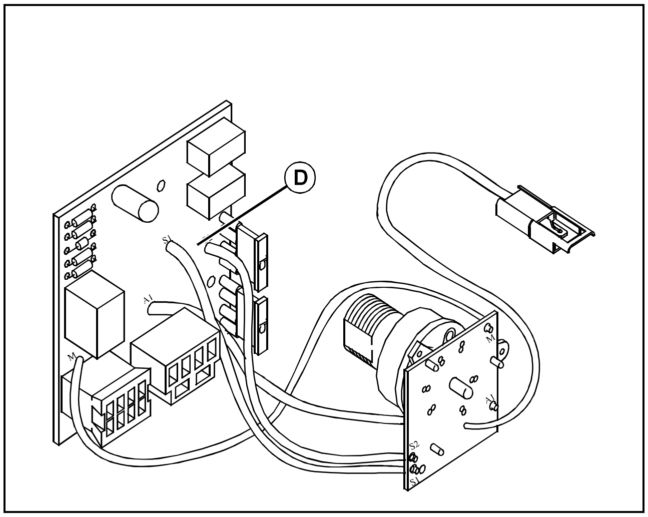


(1) Is there continuity to ground at A1 Interlock Module connector X2, pin E (C)?

Yes - Go to next step.

No - Check 101 and 105 Blk wires.

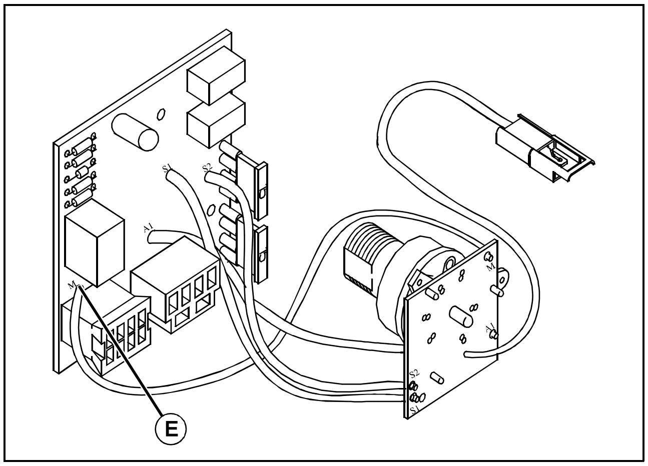
System: Ignition Circuit



(2) Is there continuity to ground at interlock module S2 solder joint (D)?

Yes - Go to next step.

No - Replace A1 Interlock Module.

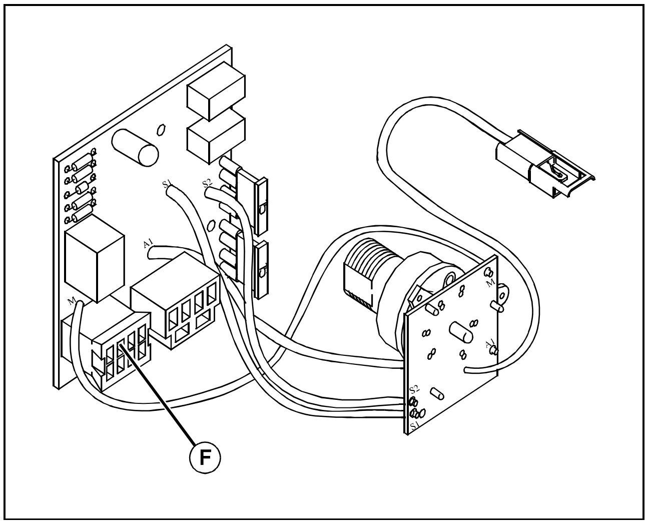


(3) Is there continuity to ground at interlock module "M" solder joint connection (E)?

Yes - Go to next step.

No - Check interlock module M an S2 Wht wires and connections. If OK, replace interlock module.

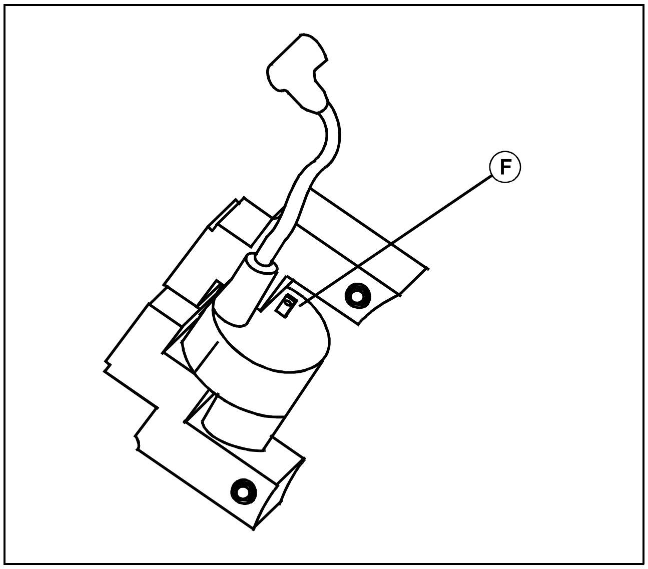
System: Ignition Circuit



(4) Is there continuity to ground at interlock module X2, pin B (F)?

Yes - Go to next step.

No - Replace interlock module.



(5) Measured at ignition coil, is there continuity to ground at 940 Wht wire?

Yes - Go to."Procedure C" on page 286.

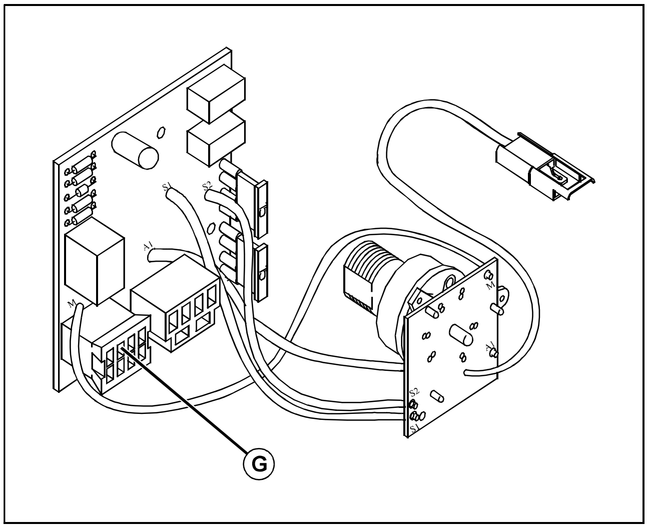
No - Check 940 Wht wire, X4 and X5 wires and connections.

Procedure C

Test Conditions:

- Key switch in RUN position - Engine NOT running.
- PTO/RIP switch OFF.
- Parking brake UNLOCKED.
- Seat switch OFF.

System: Ignition Circuit



(1) Is there continuity to ground at A1 Interlock Module connector X2, pin B (G)?

Yes - See “Cranking Circuit Diagnosis” on page 279.

No - If there is infinity ohms between pin B and ground, see See “Cranking Circuit Diagnosis” on page 279.

No - Replace interlock module.

Ignition Circuit Operation - LX279

Function:

o create a spark that ignites the fuel/air mixture in the engine.

Operating Conditions:

- Key switch in START or RUN position.
- Operator ON seat. (Seat switch CLOSED).
- PTO/RIP switch ON or OFF position.
- Parking brake LOCKED or UNLOCKED.

or,

- Key switch in START or RUN position.
- Operator OFF seat (Set switch OPEN).
- PTO/RIP switch in OFF position.
- Parking brake LOCKED (Brake/Neutral start switch CLOSED).

System Operation:

NOTE: The key switch is connected to the printed circuit board (A1 Interlock Module) by soldered wire connections. Components are solid state and are not serviced separately except for the 15 amp fuses. Lines within dashed border of the Interlock Module (A1) except for key switch connections are circuit paths on the circuit board are not wires in the harness.

The ignition system is a transistor-controlled magneto design. Ignition timing is controlled by the transistor and is not adjustable. As the engine turns over, (seeSee “Cranking Circuit Diagnosis” on page 279) the flywheel magnet induces current into the magneto ignition coil, which in turn produces current high enough to jump the spark plug(s) gap, creating spark to ignite the engine fuel/ air mixture.

The triggering signals are generated as an extended segment on the outside edge of the flywheel moves past each of the pulser coils (B3 and B4). These triggering signals are transferred to the ignition module (A2). The ignition module acts an electronic switch controlling the timing of the flow of current (Ignition Circuit) to the primary windings of the Ignition coils (T1 and T2).

As the flywheel rotates prior to the spark plugs firing, the ignition module allows current from the battery to the primary windings of the ignition coils. When a signal from the pulser coil is received at the ignition module, current flow to the primary winding is stopped. As the voltage in the primary winding drops from battery voltage to 0 volts, a strong magnetic field is created around the wires of both the primary and secondary windings. This strong magnetic field generates a voltage in the secondary windings of the coil. The voltage generated in the secondary windings is much higher than the battery voltage that was applied to the primary windings due to the greater number of windings. The high voltage of the secondary windings creates a spark at the spark plug (E1 or E2).

Shutting Engine Off - LX279

Function:

To shut the engine off by removing power from the ignition coil that is supplied through the ignition relay.

Operating Conditions:

- Key switch in OFF position.
- Operator OFF seat with PTO engaged.
- Operator OFF seat with transmission engaged.

System Operation:

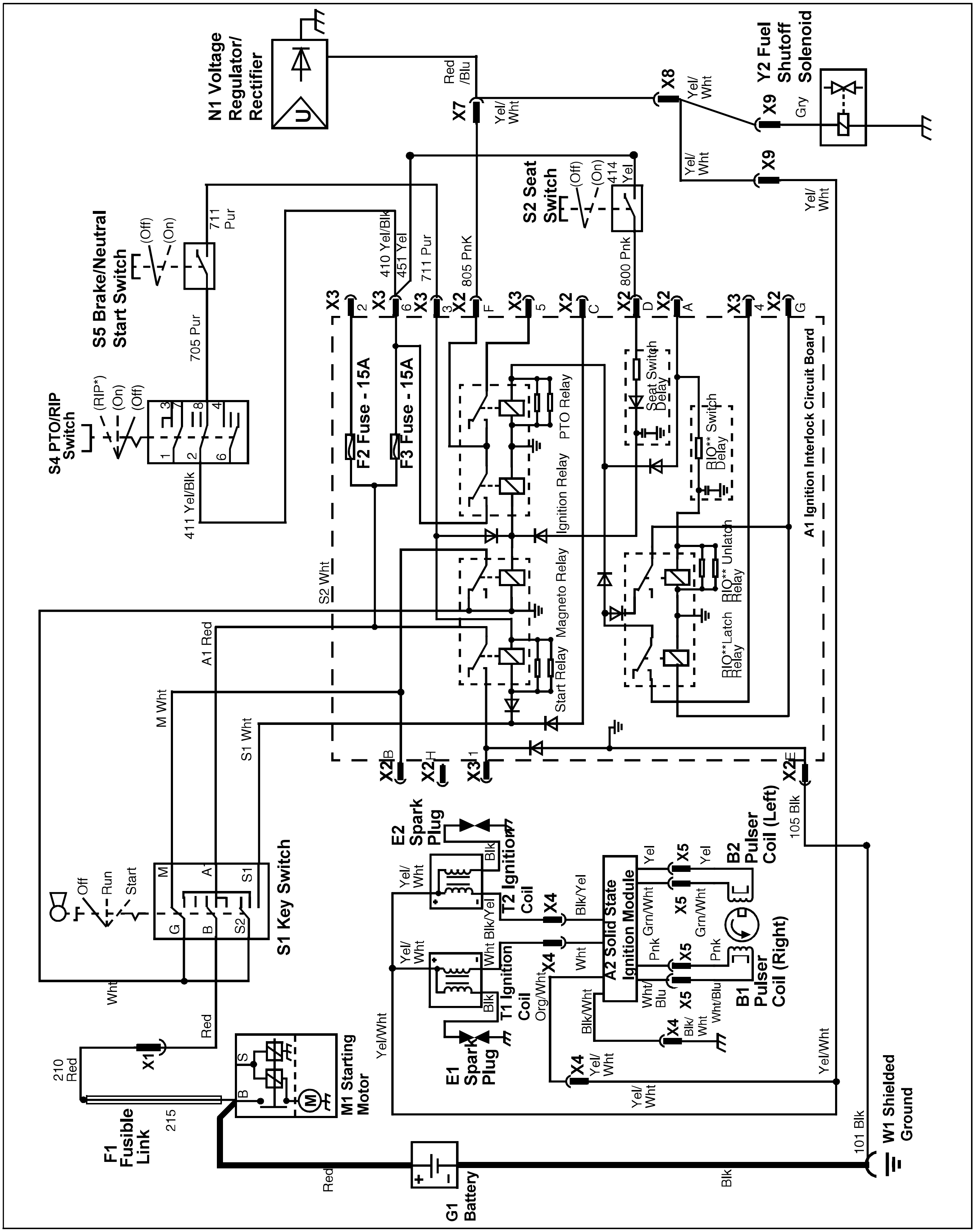
The engine is shut off by grounding the ignition coils (T1) and (T2). With the ignition primary coil grounded, a spark cannot be produced.

When the key switch (S1) is turned to the OFF position, a path to ground is created through the key switch Wht wire (M) solder connection and back to the interlock module through the Wht wire (S2) solder connection. In addition the power circuit current flow is stopped at the key switch. This de-energizes the magneto relay providing a path to ground for ignition coil through the magneto relay.

The magneto relay coil is energized by current from the seat switch circuit or neutral start circuit. If the operator gets off the seat (seat switch opens) with the PTO engaged or with the transmission engaged, current flow to the magneto relay coil is stopped.

The seat switch or brake/neutral start switch also energize the ignition relay. Whenever the ignition relay is de-energized, the fuel shutoff solenoid is also de-energized and fuel flow to the carburetor is stopped.

Ignition Circuit Schematic - LX279


N1 Voltage Regulator/ Rectifier
Y2 Fuel Shutoff Solenoid
S2 Seat Switch
(Off)
(On)
S5 Brake/Neutral Start Switch
S4 PTO/RIP Switch
(RIP*)
(On)
(Off)
A1 Ignition Interlock Circuit Board
F2 Fuse - 15A
F3 Fuse - 15A
PTO Relay
Ignition Relay
Magneto Relay
Start Relay
Seat Switch Delay
BIO** Switch Delay
BIO** Unlatch Relay
BIO**Latch Relay
S1 Key Switch
Off
Run
Start
G
B
S2
M
A
S1
E2 Spark Plug
T2 Ignition Coil
T1 Ignition Coil
E1 Spark Plug
A2 Solid State Ignition Module
B2 Pulser Coil (Left)
B1 Pulser Coil (Right)
M1 Starting Motor
F1 Fusible Link
G1 Battery
W1 Shielded Ground
X1
X2
X3
X4
X5
X7
X8
X9
Red /Blu
Yel/ Wht
Gry
414 Yel
800 Pnk
805 PnK
711 Pur
451 Yel
410 Yel/Blk
711 Pur
705 Pur
411 Yel/Blk
S2 Wht
A1 Red
M Wht
S1 Wht
Wht
Red
210 Red
215
105 Blk
101 Blk
Blk
Blk/Yel
Wht
Org/Wht
Blk/Wht
Blk/ Wht
Grn/Wht
Pnk
Wht/ Blu
Wht/Blu
Yel
Yel/Wht

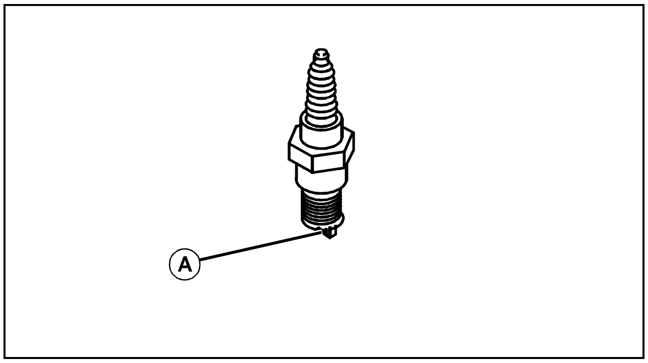
Ignition Circuit Diagnosis - LX279

Procedure A

Test Conditions:

- Key switch in OFF position.
- Park brake ON (Brake/Neutral start switch CLOSED).
- PTO/RIP switch OFF (DISENGAGED).
- Engine cool to avoid burns.

System: Ignition Circuit



(1) Are the spark plugs clean and gapped correctly (A)?

Yes - Go to “Procedure B” on page 289.

No - Adjust air gap or replace spark plugs.

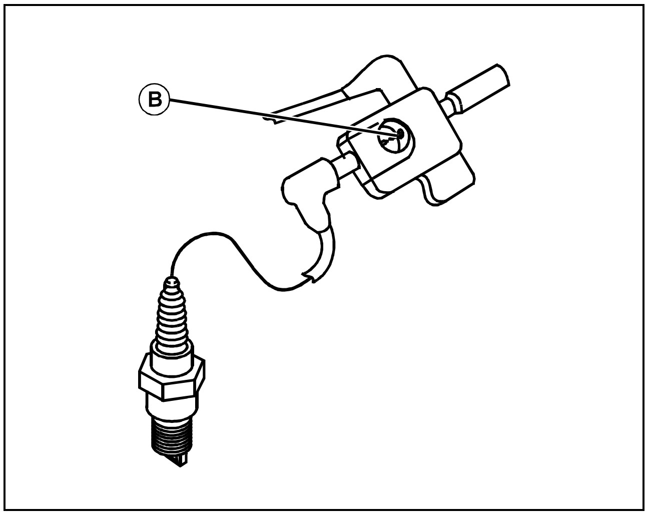
Procedure B

Test Conditions:

NOTE: Engine will turn over and can start during this test.

- Key switch in START position.
- Park brake ON.
- PTO/RIP switch OFF (DISENGAGED).

System: Ignition Circuit



(1) After installing the spark tester, is a spark present (B)?

Yes - Check spark plug air gap and condition of spark plugs. Adjust gap or replace spark plugs as necessary.

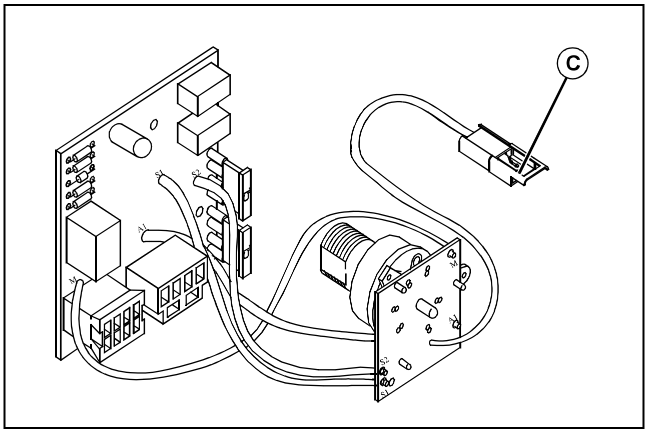
No - Test ignition coils and ignition module.

Procedure C

Test Conditions:

- Key switch in RUN position - Engine NOT running.
- Operator ON seat (Seat switch CLOSED).
- Parking brake LOCKED (Brake/Neutral start switch CLOSED).

System: Ignition Circuit

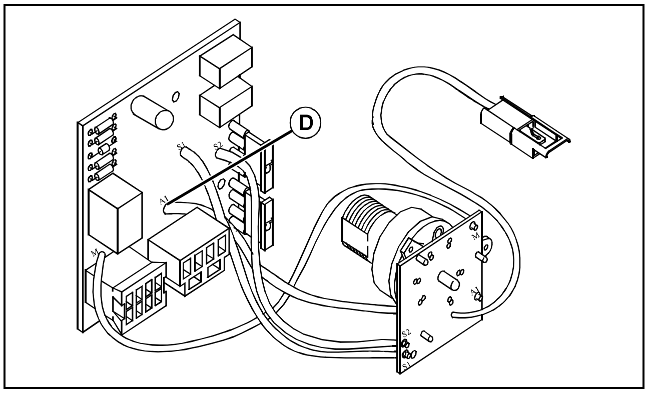


(1) Is battery voltage present at S1 Key Switch X1 connector, Red wire, Pin B (C)?

System: Ignition Circuit

Yes - Go to next step.

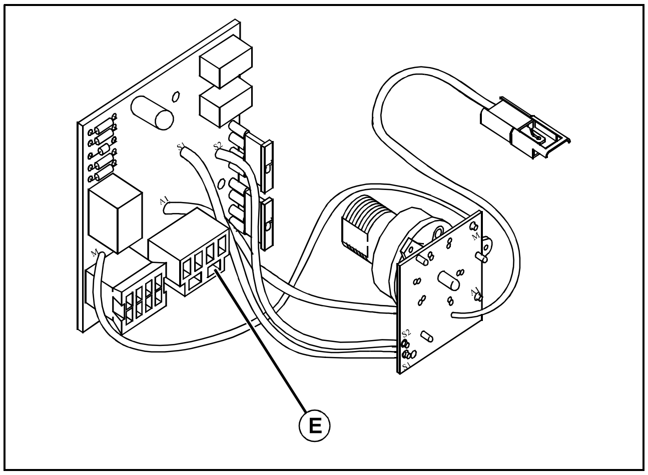
No - Check F1 fusible link, 210 Red wire, X1 connector to key switch and connections.



(2) Is battery voltage present at A1 Interlock Module solder point "A" (D)?

Yes - Go to next step.

No - Replace interlock module.



(3) Is battery voltage present at interlock module connector X3, pin 6 (E)?

Yes - Go to next step.

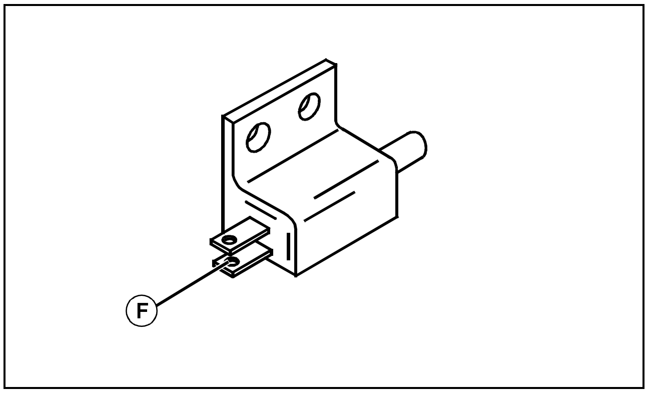
No - Check F3 fuse. If OK, replace interlock module.

(4) Is battery voltage present at S4 PTO/RIP Switch 411 Yel wire?

Yes - Go to next step.

No - Check 411 Yel wire and connections.

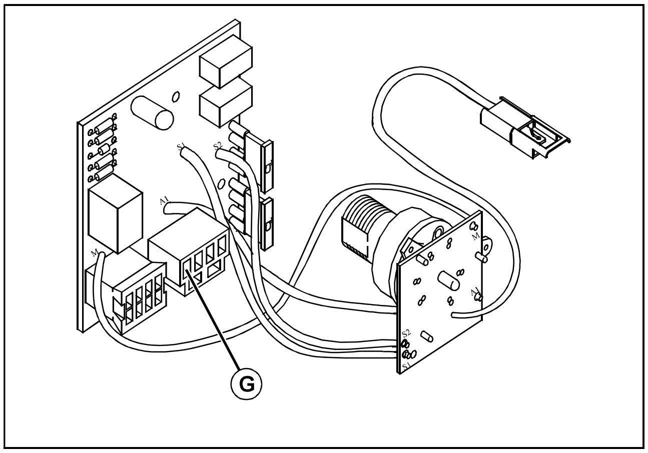
System: Ignition Circuit



(5) Is battery voltage present at S5 Brake/Neutral start switch, 706 Pur wire (F)?

Yes - Go to next step.

No - Check 706 Pur wire and connections. If OK, replace PTO/RIP switch.

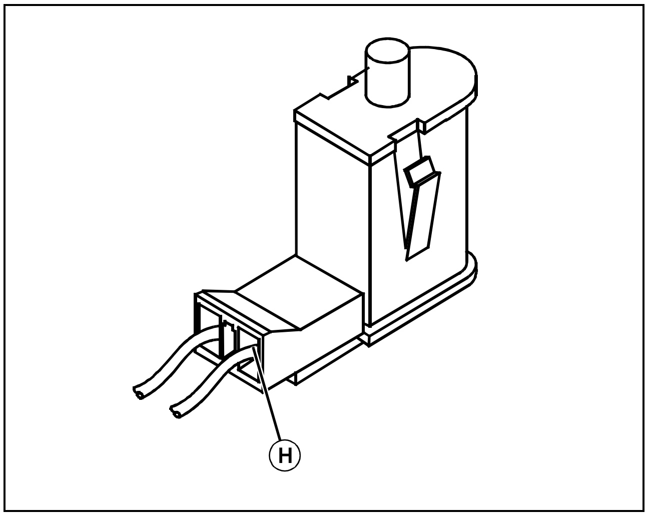


(6) Is battery voltage present at interlock module connector X3, pin 3 (G)?

Yes - Go to next step.

No - Check 711 Pur wire and connections. If OK, replace Brake/Neutral start switch.

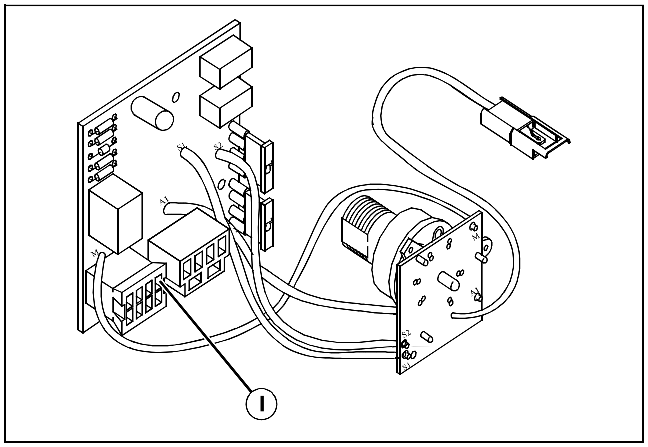
System: Ignition Circuit



(7) Is battery voltage present at 451, 452, and 414 Yel wires of S2 seat switch (H)?

Yes - Go to next step.

No - Check 451, 452, and 414 Yel wire and connections.



(8) Is battery voltage present at interlock module connector X2, pin D (I)?

Yes - See “Procedure D” on page 292.

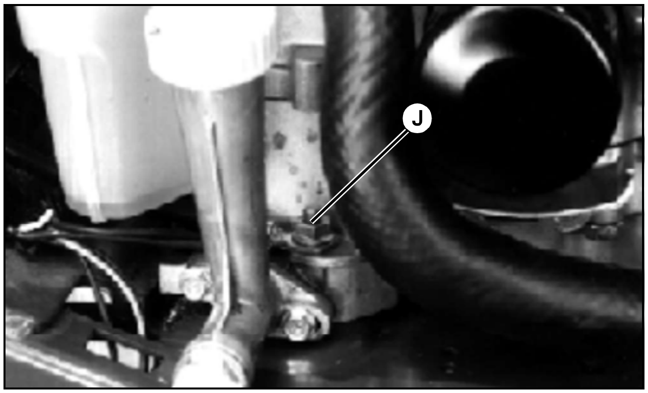
No - Check 800 Pnk wire and connections. If OK, replace seat switch.

Procedure D

Test Conditions:

- Key switch in OFF position.

System: Ignition Circuit

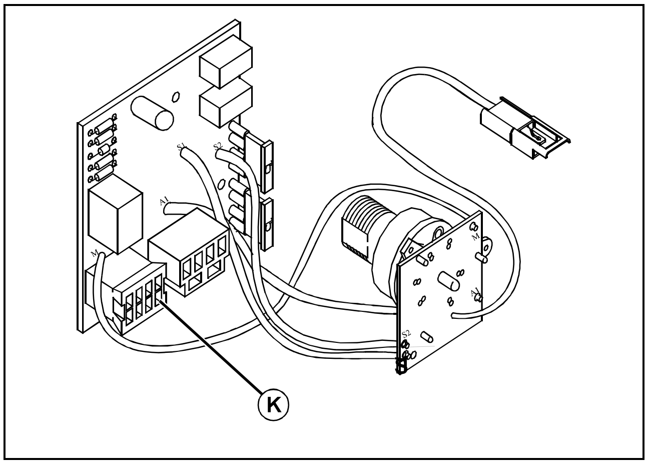


M83225

(1) Is there 0.1 ohm or less between engine ground (I) and negative battery terminal?

Yes - Go to next step.

No - Check battery negative cable and shielded ground connection.

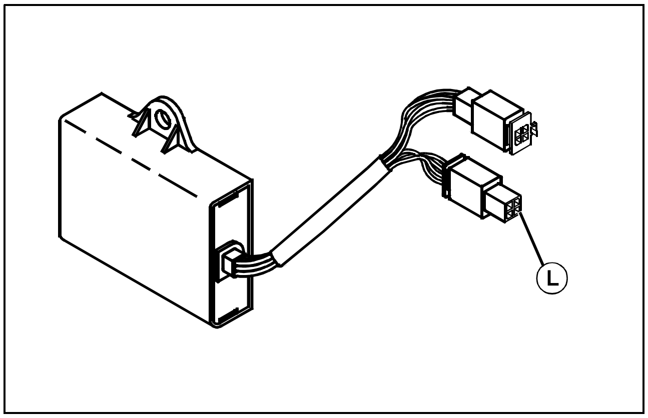


(2) Is there 0.1 ohm or less between A1 Interlock Module connector X2, pin E (J), and ground?

Yes - Go to next step.

No - Check 101 and 105 Blk wires and harness to engine ground harness.

System: Ignition Circuit



(3) Is there 0.1 ohm or less between ignition module Blk/Wht wire (L) and ground?

Yes - Test ignition coils. See “Ignition Coil Test - LX279” on page 339.

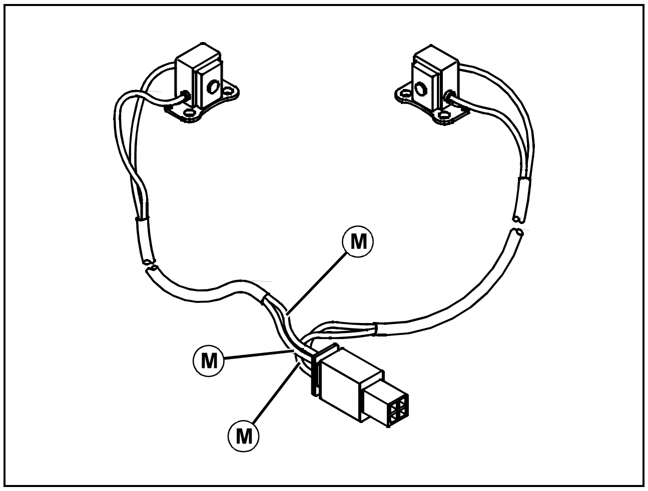
No - Check Blk/Wht wire ground connection.

Procedure D

Test Conditions:

- Key switch in START position.
- Meter set for AC voltage.
- Voltage test light connected to battery negative (-) terminal (checking for current pulses).

System: Ignition Circuit



(1) Is there 0.1 - 1 VAC at left and right pulser coils Wht/Blu and the Grn/Wht and Yel leads (M)?

Yes - Go to next step.

System: Ignition Circuit

No - Check pulser coil connections and test pulser coil resistance.

(2) Does the test light flash rapidly at the pulser coils?

Yes - Go to next step.

No - Check the ignition module. See “Ignition Module Test - LX279” on page 339.

(3) Does the test light have a steady glow?

No - See “Procedure E” on page 292.

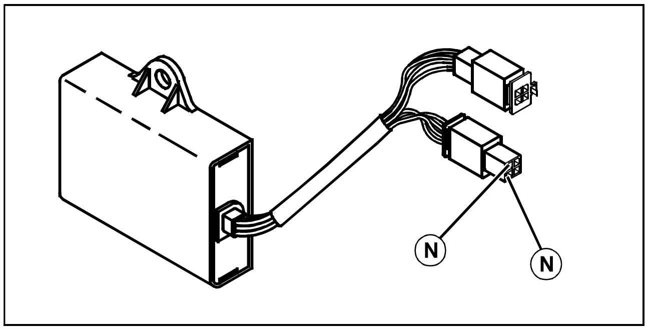
Yes - Check ignition coil ground circuit.

Procedure E

Test Conditions:

- Key switch in RUN position.

System: Ignition Circuit



(1) Is battery voltage present at Wht and Blk/Yel wires (N) of ignition module?

No - Check Wht and Blk/Yel wires at ignition module.

No - Replace ignition module with a known good module.

Charging Circuit Operation

Function:

To maintain battery voltage to 12.4 volts DC or higher.

Operating Conditions:

- Key switch in RUN position.
- Engine RUNNING.

System Operation:

NOTE: The key switch is connected to the printed circuit board (A1 Interlock Module) by soldered wire connections. Components are solid state and are not serviced separately except for the 15 amp fuses. Lines within dashed border of the Interlock Module (A1) except for key switch connections are circuit paths on the circuit board are not wires in the harness.

The charging system is a permanent magnet and stator design. Charging output is controlled by a regulator/rectifier.

Old style voltage regulator/rectifier: A battery discharge light warns the operator if the stator stops charging. The battery discharge light circuit monitors stator output, not battery voltage.

New style voltage regulator/rectifier: A battery discharge light warns the operator if the battery voltage drops below the preset threshold (12.4 VDC). The battery discharge light circuit monitors battery voltage, not stator output.

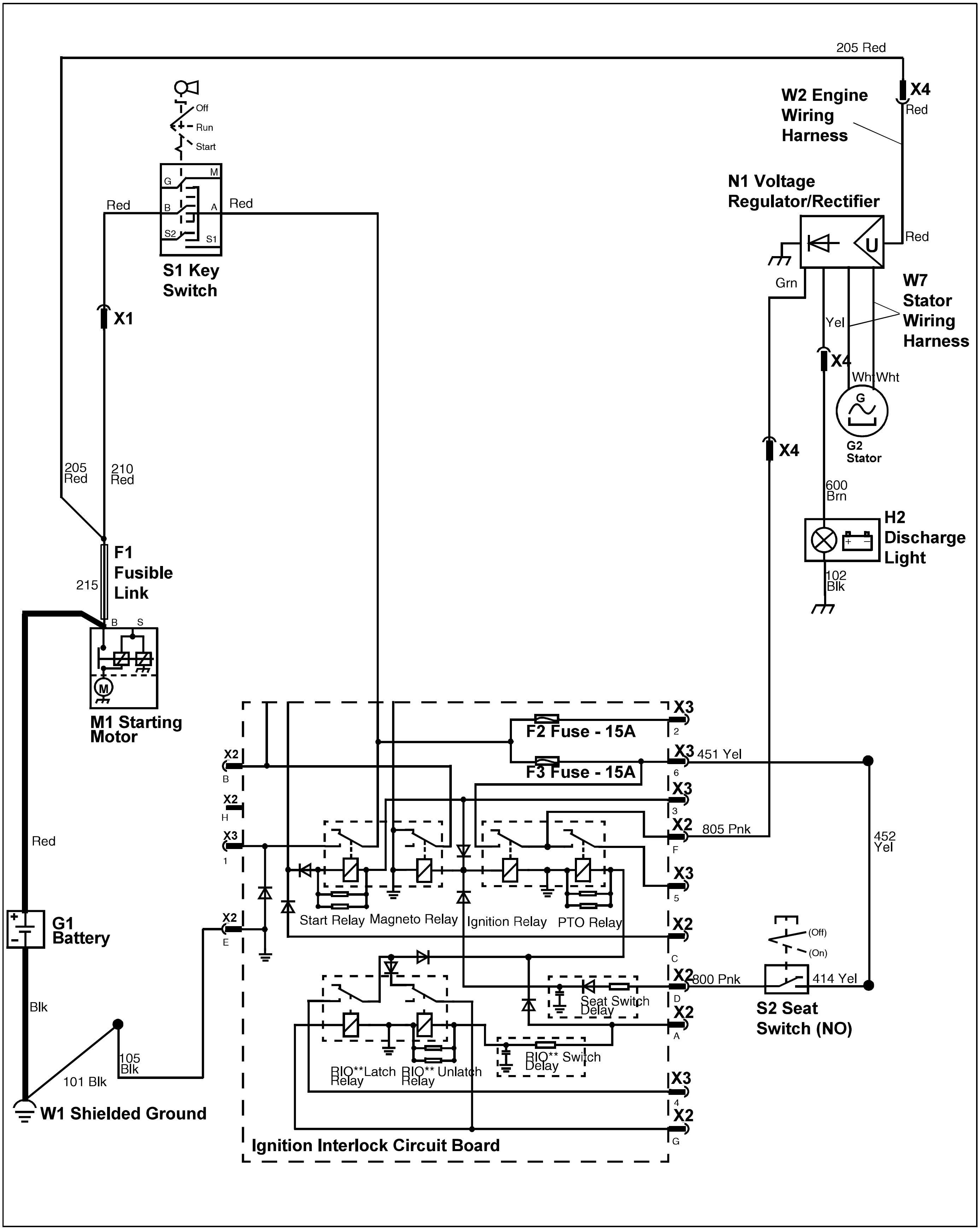
The 210 Red wire provides current to the key switch (S1) and protects the charging circuit with a fusible link (F1). With the key switch in the RUN position, current flows from battery (G1) positive (+) terminal to fusible link, 210 Red wire, key switch, Red wire, interlock module, 15 amp fuse (F3), 451, 452, and 414 Yel wires, seat switch (S2) (operator on seat), 800 Pnk wire, interlock module, energizing the ignition relay closing the contacts. The ignition relay contacts receive power from the 15 amp fuse (F3) and provide current to the 805 Pnk wire, engine connector (X4), Grn wire, and regulator/rectifier (N1). The voltage sensing circuit allows the regulator/rectifier to monitor battery voltage.

As the flywheel turns, a permanent magnet located in the flywheel induces AC current in the stator (G2) windings. The AC current flows to the regulator/rectifier. The regulator/rectifier converts the AC current to DC current needed to charge the battery.

If the battery voltage is low, the regulator/rectifier allows DC current to flow to the battery to charge it through the 205 Red wire. When the battery is fully charged, the regulator stops current flow to the battery.

The ground circuit provides a path to ground for the regulator/rectifier.

Charging Circuit Schematic


205 Red
X4
Red
W2 Engine Wiring Harness
Off
Run
Start
G
M
B
A
S2
S1
Red
Red
S1 Key Switch
N1 Voltage Regulator/Rectifier
U
Red
Grn
W7 Stator Wiring Harness
Yel
X1
X4
Wht
Wht
G
G2 Stator
X4
205 Red
210 Red
600 Brn
H2 Discharge Light
F1 Fusible Link
215
102 Blk
B
S
M
M1 Starting Motor
X3 2
F2 Fuse - 15A
X2 B
X3 6
451 Yel
F3 Fuse - 15A
X2 H
X3 3
X3 1
X2 F
805 Pnk
452 Yel
Red
X3 5
Start Relay
Magneto Relay
Ignition Relay
PTO Relay
G1 Battery
X2 E
X2 C
(Off)
(On)
X2 D
800 Pnk
414 Yel
Seat Switch Delay
S2 Seat Switch (NO)
Blk
X2 A
105 Blk
BIO** Switch Delay
BIO**Latch Relay
BIO** Unlatch Relay
101 Blk
X3 4
W1 Shielded Ground
X2 G
Ignition Interlock Circuit Board

Charging Circuit Diagnosis

Procedure A

Test Conditions:

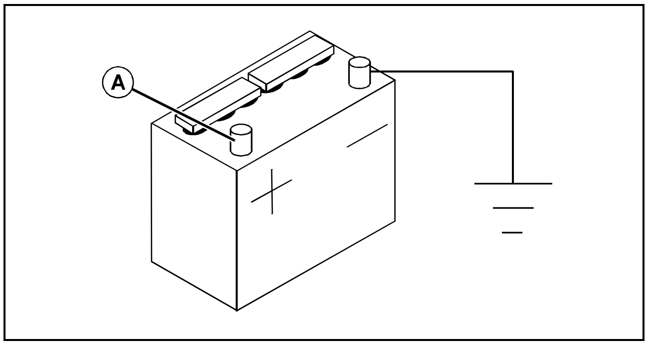
- Key switch OFF.
- Headlights OFF.

System: Charging Circuit

(1) Is the battery fully charged and pass a load test? See “Battery - Load Test” on page 331, and See “Battery - Charge” on page 331.

Yes - Go to next step.

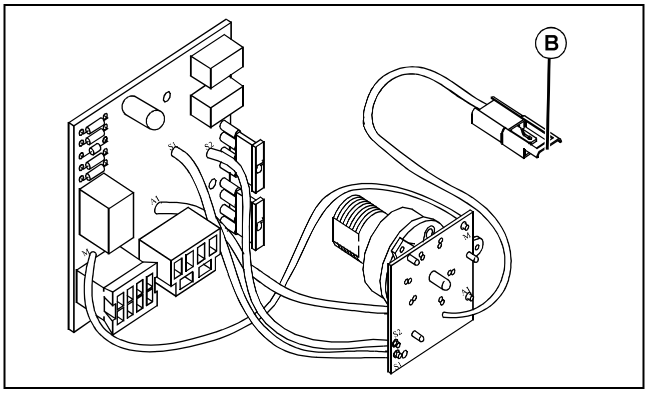
No - Charge battery and replace as needed.



(2) Is there 12.4 VDC or higher (battery voltage) at positive (+) battery terminal (A)?

Yes - Go to next step.

No - Charge the battery. See “Battery - Charge” on page 331.

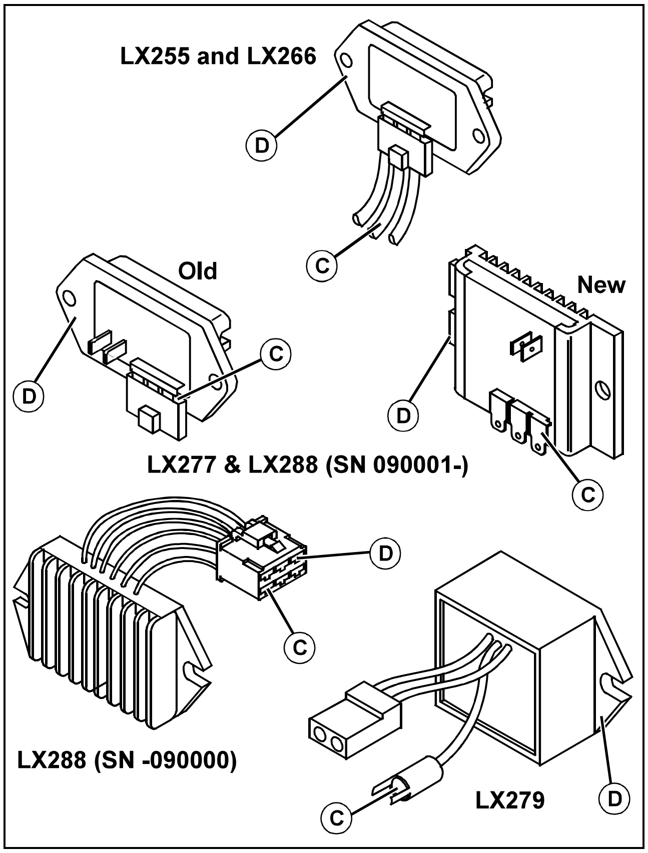


(3) Is battery voltage present at S1 Key Switch X1 connector, 210 Red wire (B)?

Yes - Go to next step.

No - Check F1 fusible link, 210 Red wire, X1 connector to key switch and connections.

System: Charging Circuit



(4) Is battery voltage present at 205 Red wire (C) of N1 Voltage Regulator/Rectifier?

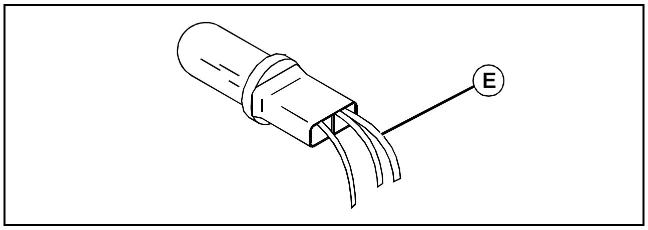
Yes - Go to next step.

No - Check 205 Red wire and connections.

(5) Does the voltage regulator/rectifier have continuity to ground (D)?

Yes - Go to next step.

No - Check battery negative cable and shielded ground.



(6) Does the AH2 discharge light have continuity to ground (E)?

Yes - See “Procedure B” on page 296.

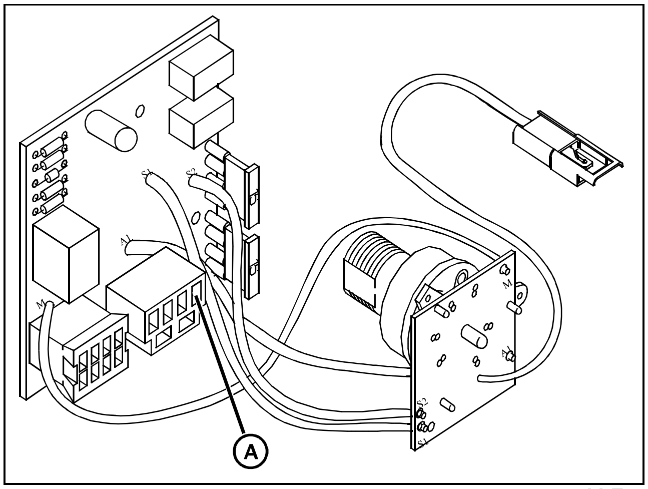
No - Check 101 Blk wire.

Procedure B

Test Conditions:

- Key switch in RUN position - Engine NOT running.
- Seat switch closed (operator ON seat).
- Headlights OFF.

System: Charging Circuit

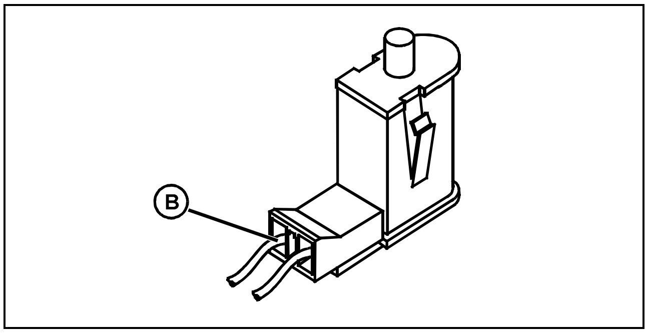


MIF

(1) Is battery voltage (12.4 VDC or higher) present at A1 Interlock Module connector X3, pin 6 (A)?

Yes - Go to next step.

No - Check F3 fuse. If OK, replace interlock module.



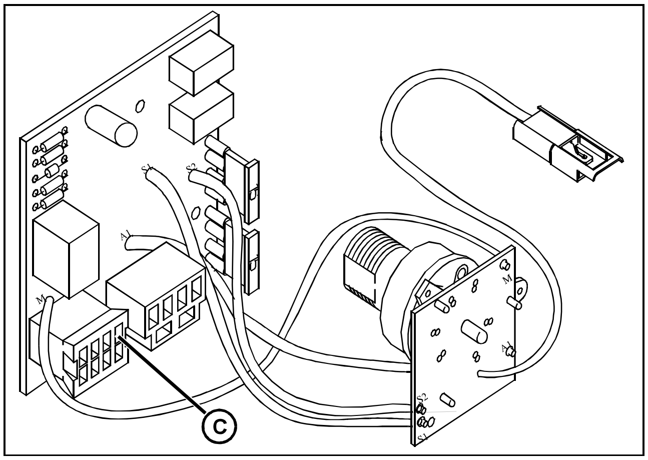
MIF

(2) Is battery voltage present at S2 Seat Switch (B)?

Yes - Go to next step.

No - Check 451, 452, and 414 Yel wires and connections.

System: Charging Circuit

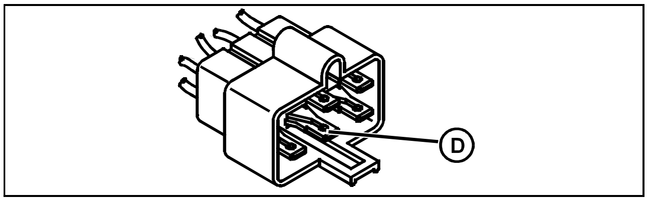


MIF

(3) Is battery voltage present at interlock module connector X2, pin D (C)?

Yes - Go to next step.

No - Check 800 Pnk wire and connections. If OK, replace seat switch.



MIF

(4) Is battery voltage present at engine connector X4 (D)?

Yes - Go to next step.

No - Check 805 Pnk wire and connections. If OK, replace interlock module.

(5) Is battery voltage present at voltage regulator/ rectifier?

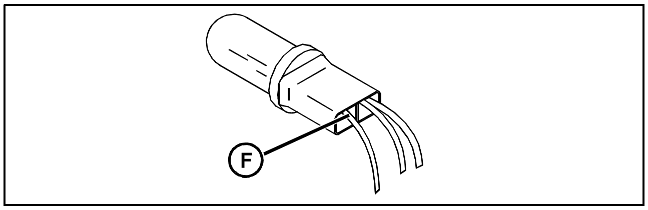
Yes - Go to next step.

No - LX255, LX266 & LX288 (SN - 090000): Check Red wire and connections.

No - LX277 & LX288 (SN 090001 -): Check Grn wire and connections.

No - LX279: Check Red/Blu wire and connections.

System: Charging Circuit



MIF

(6) Is voltage present at the discharge light?

Yes - See “Procedure C” on page 297.

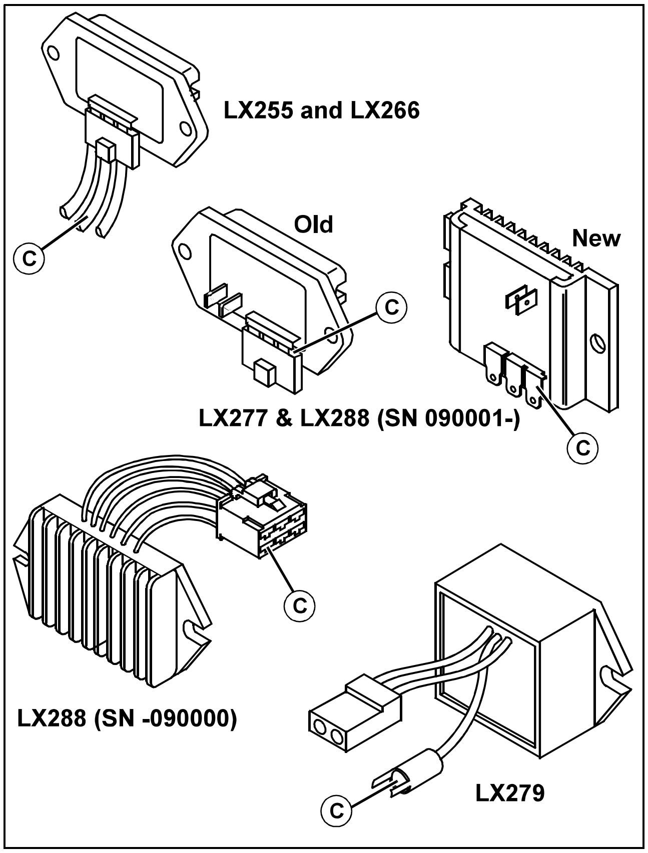
No - Check 600 Brn wire and connections. If OK, replace voltage regulator/rectifier.

Procedure C

Test Conditions:

- Engine RUNNING at low idle then increased to high idle during test.
- Stator CONNECTED to voltage regulator/rectifier.

System: Charging Circuit



(1) Does the voltage at N1 voltage regulator/ rectifier, 205 Red wire (A), raise to 14.2 - 14.8 volts?

System: Charging Circuit

Yes - Charging circuit is functional. Check accessory and/or optional components for excess amp draw.

No - See “Procedure D:” on page 297.

Procedure D:

Test Conditions:

- Engine RUNNING at low idle then increased to high idle during test.
- Stator DISCONNECTED from voltage regulator/ rectifier.

System: Charging Circuit Unregulated Output

(1) Is the voltage at the connector to the stator at least 26 VAC at low idle and high idle?

Yes - Stator output is within specification. Test voltage regulator/rectifier. See “Regulator/Rectifier Test” on page 334. Replace as needed.

No - Test flywheel magnets. See “Flywheel Magnet Test” on page 335.

No - Verify engine rpm is set correctly. If OK, replace stator.

PTO Circuit Operation - PTO Off

Function:

To provide power to energize the PTO relay and clutch.

Operating Conditions:

- Key switch in RUN position.
- PTO/RIP switch OFF.
- Operator on seat (Seat switch closed).

or,

- Key switch in RUN position.
- PTO/RIP switch OFF.
- Parking brake locked. (Brake/Neutral start switch CLOSED).

System Operation:

NOTE: The key switch is connected to the printed circuit board (A1 Interlock Module) by soldered wire connections. Components are solid state and are not serviced separately except for the 15 amp fuses. Lines within dashed border of the Interlock Module (A1) except for key switch connections are circuit paths on the circuit board are not wires in the harness.

The PTO circuit uses a seat switch (S2), ignition relay, and PTO relay to stop current flow to the PTO clutch (Y1), if the operator gets off the seat with the PTO engaged.

The power circuit provides current to the key switch (S1) and protects the PTO circuit with a 15 amp fuse (F3). Current flows from the battery (G1) positive (+) terminal to the fusible link (F1), 210 Red wire and key switch. With the key switch in the RUN position, current flows through the 15 amp fuse (F3) to the ignition relay N.O. contact terminal, 451, 452, and 414 Yel wires, seat switch (S2) contacts closed (operator on seat), 800 Pnk wire, to the interlock module to energize the ignition relay. With the ignition relay energized, its contacts close and provide power to the PTO relay common contact terminal, 805 Pnk wire, engine connector X4, Grn wire to fuel shutoff solenoid, Grn wire to the voltage regulator/rectifier (N1), 810 Pnk wire and PTO/RIP switch (S4).

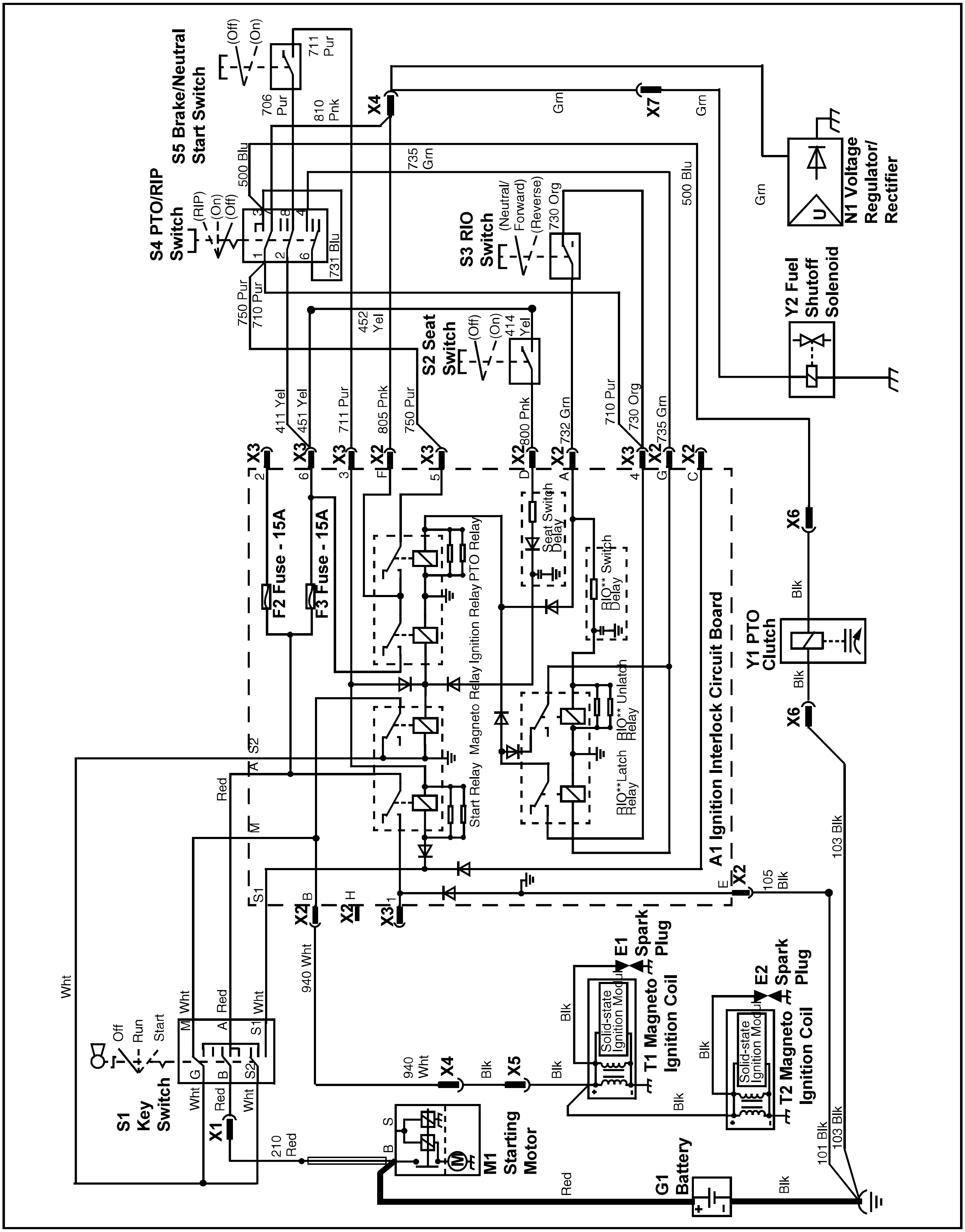
The PTO/RIP switch is used in the PTO safety circuit to prevent the PTO relay from energizing if the PTO/RIP switch is in the ON position when the key switch is turned on. With the PTO/RIP switch OFF (PTO disengaged), current flows from the 810 Pnk wire, across the PTO/RIP switch contact to the 710 Pur and 730 Org wires, RIO switch (S3) N.C. contacts (neutral/forward position), 732 Grn wire into the interlock module to energize the PTO relay coil. The PTO relay contacts close suppling power to the 750 Pur wire. The 750 Pur wire connects back at the PTO/RIP switch to the 710 Pur wire. This then creates a loop to energize the PTO relay. Power is now available at the PTO/RIP switch to energize the RIO circuit and the PTO clutch when the PTO/RIP switch is moved to the ON position.

Once the PTO relay is energized it can be deenergized if the operator turns the key switch OFF, or operates the machine in reverse without placing the PTO/RIP switch into the Reverse Implement Position (RIP).

The PTO/RIP switch is also used in the neutral start circuit to prevent the magneto relay, ignition relay and start relay from energizing if the PTO is engaged. With the PTO/RIP switch closed (PTO disengaged), current flows to the brake/neutral start switch (S5) and back to the interlock module to supply power to the magneto, ignition and start relays.

The ground circuit, 101 and 105 Blk wires, provides a path to ground for the magneto, ignition and PTO relay coils.

PTO Circuit Schematic - PTO Off


S5 Brake/Neutral Start Switch
(Off)
(On)
706 Pur
711 Pur
810 Pnk
S4 PTO/RIP Switch
(RIP)
(On)
(Off)
500 Blu
731 Blu
750 Pur
710 Pur
X4
735 Grn
Grn
X7
Grn
N1 Voltage Regulator/ Rectifier
Grn
500 Blu
S3 RIO Switch
(Neutral/ Forward)
(Reverse)
730 Org
Y2 Fuel Shutoff Solenoid
452 Yel
S2 Seat Switch
(Off)
(On)
414 Yel
411 Yel
451 Yel
711 Pur
805 Pnk
750 Pur
800 Pnk
732 Grn
710 Pur
730 Org
735 Grn
X3
X2
F2 Fuse - 15A
F3 Fuse - 15A
PTO Relay
Ignition Relay
Seat Switch Delay
RIO** Switch Delay
Magneto Relay
Start Relay
RIO** Unlatch Relay
RIO**Latch Relay
A1 Ignition Interlock Circuit Board
X6
Blk
Y1 PTO Clutch
Blk
X6
103 Blk
105 Blk
E
Red
Wht
A
S2
M
S1
B
H
940 Wht
E1 Spark Plug
T1 Magneto Ignition Coil
Solid-state Ignition Module
E2 Spark Plug
T2 Magneto Ignition Coil
Off
Run
Start
S1 Key Switch
G
X1
210 Red
X4
X5
M1 Starting Motor
S
B
G1 Battery
101 Blk
103 Blk
Red

PTO Circuit Operation - PTO On

Function:

To provide power to energize or de-energize the PTO clutch when desired by the operator.

Operating Conditions:

- Key Switch in RUN position.
- PTO/RIP switch in ON position
- Operator on seat. (Seat switch in CLOSED position.)

System Operation:

NOTE: The key switch is connected to the printed circuit board (A1 Interlock Module) by soldered wire connections. Components are solid state and are not serviced separately except for the 15 amp fuses. Lines within dashed border of the Interlock Module (A1) except for key switch connections are circuit paths on the circuit board are not wires in the harness.

The PTO/RIP switch is used in the PTO safety circuit to prevent the PTO relay from energizing if the PTO/RIP switch is in the ON position when the key switch is turned on. With the PTO/RIP switch OFF (PTO disengaged), current flows from the 810 Pnk wire, across the PTO/RIP switch contact to the 710 Pur and 730 Org wires, RIO switch (S3) N.C. contacts (neutral/forward position), 732 Grn wire into the interlock module to energize the PTO relay coil. The PTO relay contacts close suppling power to the 750 Pur wire. The 750 Pur wire connects back at the PTO/RIP switch to the 710 Pur wire. This then creates a loop to energize the PTO relay. Power is now available at the PTO/RIP switch to energize the RIO circuit and the PTO clutch when the PTO/RIP switch is moved to the ON position.

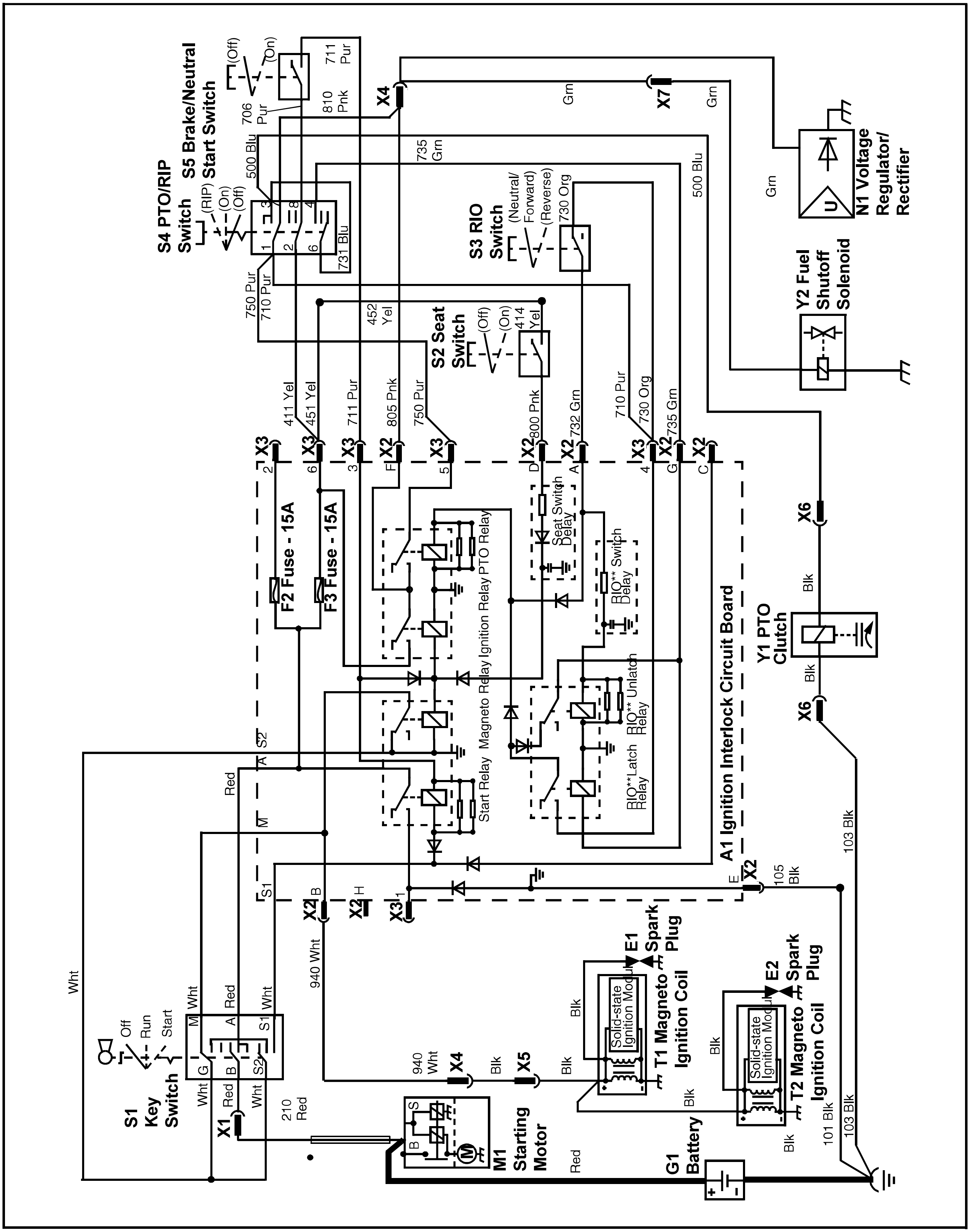
With the PTO in the ON position power is supplied from the 750 Pur wire across the PTO/RIP switch contacts to the 500 and 731 Blu wires. The 500 Blu wire supplies power to the PTO clutch and is grounded through the 103 Blk wire. At the same time the 500 Blu wire supplies power to the PTO clutch the 731 Blu wire supplies power to the momentary contacts of the PTO/RIP switch. This circuit is part of the RIO circuit to allow for operation of the machine in reverse with the PTO engaged. See “Reverse Implement Option (RIO) Circuit Operation” on page 306.

If the machine is operated in reverse without pulling the PTO/RIP switch into the Reverse Implement Position (RIP) the PTO will be disengaged. The PTO/RIP switch will then need to be placed back to the OFF position to energize the PTO relay and then pulled back to the ON position if desired.

With the PTO/RIP switch ON, current flow to the brake/neutral start switch is stopped, so the seat circuit must keep the ignition relay energized. If the operator gets off the seat with the PTO/RIP switch ON, the seat switch (S2) de-energizes the ignition and PTO relays, which stops current flow to the PTO clutch and allows the magneto relay to deenergize closing its contacts grounding the ignition system.

The ground circuit, 105 and 101 Blk wires, provides a path to ground for the magneto, ignition and PTO relay coils.

PTO Circuit Schematic - PTO On


S4 PTO/RIP Switch
(RIP)
(On)
(Off)
S5 Brake/Neutral Start Switch
(Off)
(On)
706 Pur
810 Pnk
711 Pur
500 Blu
731 Blu
750 Pur
710 Pur
X4
735 Grn
Grn
X7
Grn
N1 Voltage Regulator/ Rectifier
S3 RIO Switch
(Neutral/ Forward)
(Reverse)
730 Org
500 Blu
Y2 Fuel Shutoff Solenoid
S2 Seat Switch
(Off)
(On)
414 Yel
452 Yel
411 Yel
451 Yel
711 Pur
805 Pnk
750 Pur
800 Pnk
732 Grn
710 Pur
730 Org
735 Grn
X3
X2
F2 Fuse - 15A
F3 Fuse - 15A
PTO Relay
Ignition Relay
Magneto Relay
Start Relay
Seat Switch Delay
RIO** Switch Delay
RIO** Unlatch Relay
RIO**Latch Relay
A1 Ignition Interlock Circuit Board
X6
Blk
Y1 PTO Clutch
105 Blk
103 Blk
Red
Wht
S1 Key Switch
Off
Run
Start
G
B
S2
M
A
S1
X1
210 Red
940 Wht
X4
X5
M1 Starting Motor
E1 Spark Plug
T1 Magneto Ignition Coil
Solid-state Ignition Module
E2 Spark Plug
T2 Magneto Ignition Coil
G1 Battery
101 Blk

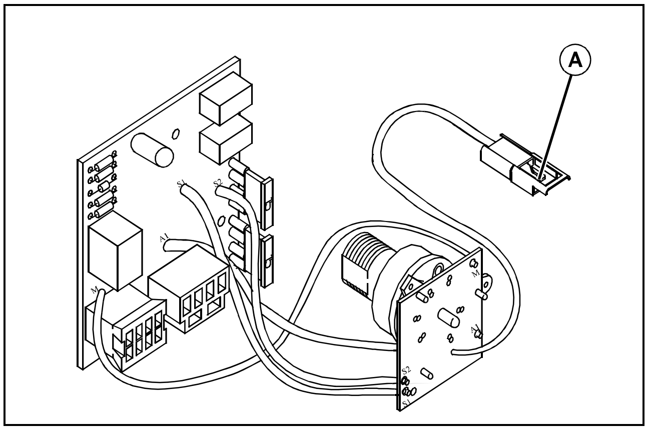
PTO Circuit Diagnosis

Test Conditions:

- Key switch in RUN position - engine NOT running.
- Operator ON seat (Seat switch closed).
- PTO/RIP switch in OFF position.

Procedure A

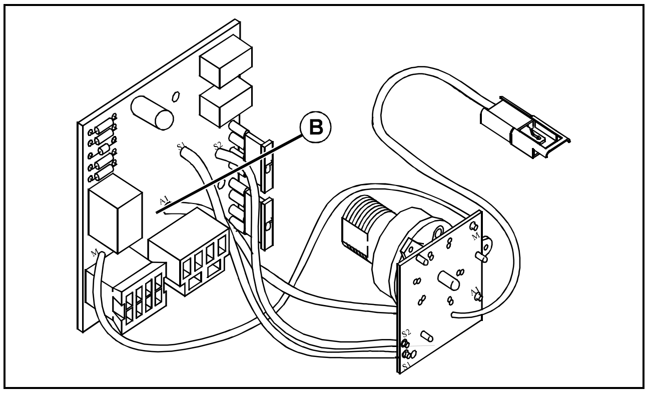
System: PTO Circuit



(1) Is battery voltage present at S1 Key Switch X1 connector?

Yes - Go to next step.

No - Check F1 fusible link, 210 Red wire, X1 connector to key switch and connections.

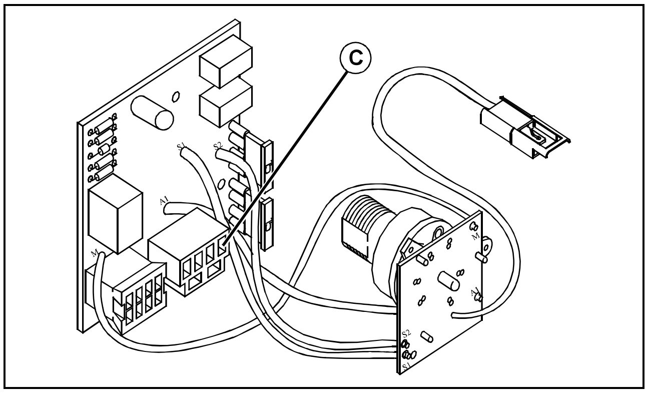


(2) Is battery voltage present at A1 Interlock Module "A" solder joint connection (B)?

Yes - Go to next step.

No - Replace A1 Interlock Module.

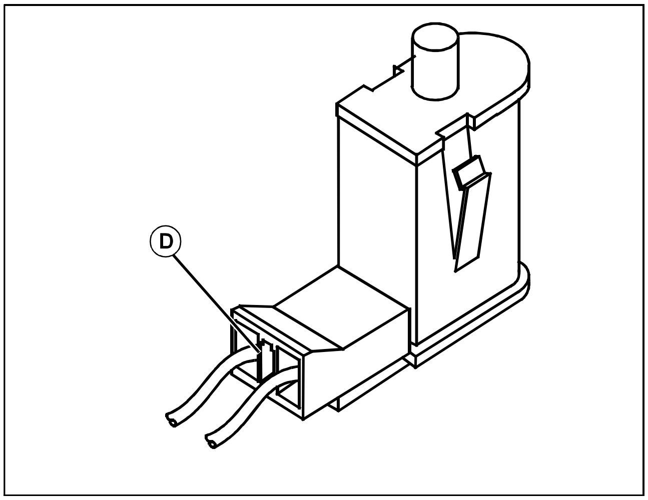
System: PTO Circuit



(3) Is battery voltage present at interlock module X3, pin 6, 451 and 411 Yel wires?

Yes - Go to next step.

No - Replace interlock module.

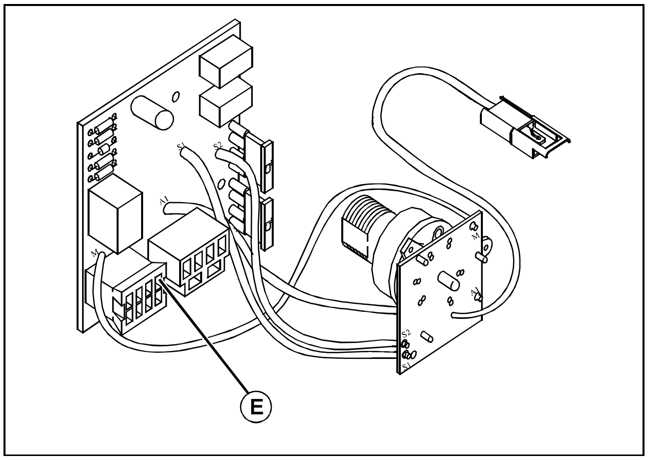


(4) Is battery voltage present at S2 Seat Switch (C)?

Yes - Go to next step.

No - Check 451, 452, and 414 Yel wires and connections.

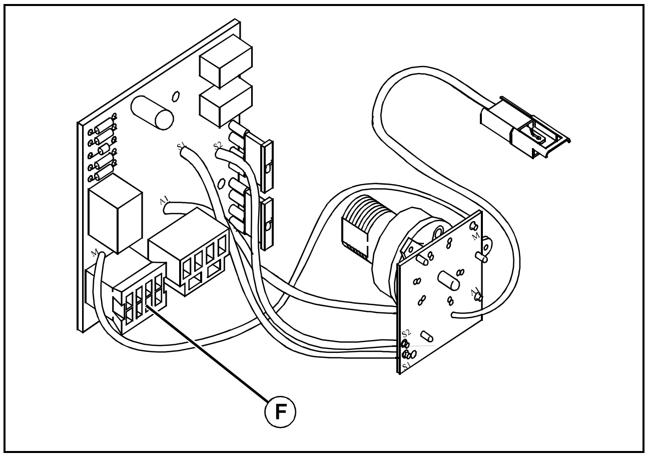
System: PTO Circuit



(5) Is battery voltage present at interlock module connector X2, pin D (E)?

Yes - Go to next step.

No - Check 800 Pnk wire and connections. If OK, replace seat switch.

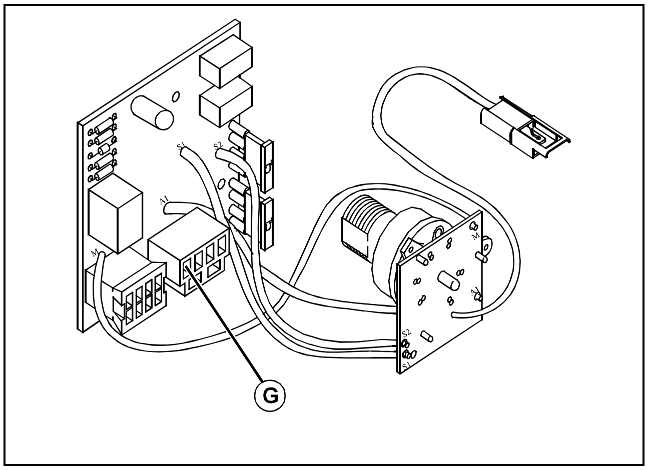


(6) Is battery voltage present at interlock module connector X2, pin F?

Yes - Go to next step.

No - Replace interlock module.

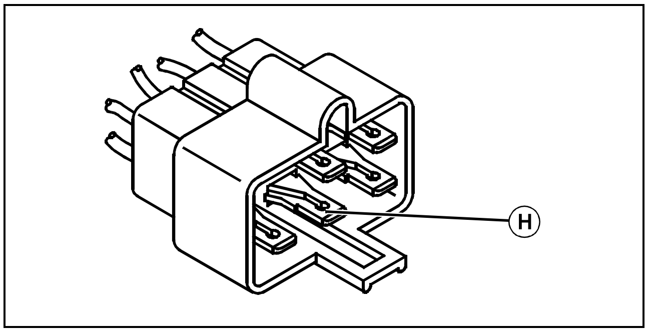
System: PTO Circuit



(7) Is there battery voltage present at interlock module connector X3, pin (G) 3?

Yes - Verify brake is OFF and drive pedals are in NEUTRAL. If OK, replace interlock module.

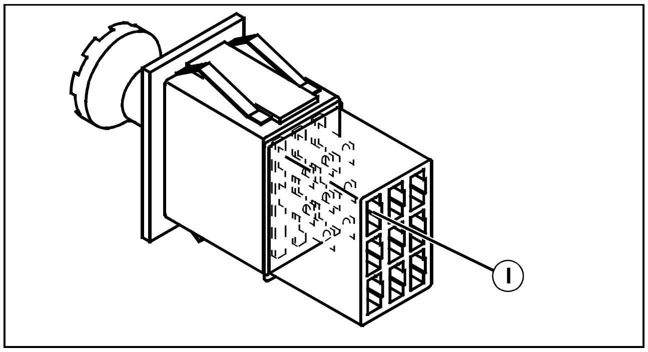
No - Go to next step.



(8) Is battery voltage present at X4 engine wiring harness connector, 805 Pnk wire (H)?

Yes - Go to next step.

No - Check 805 Pnk wire and connections.

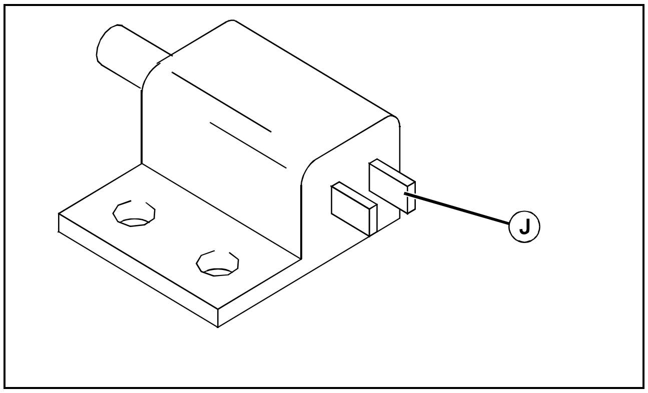


(9) Is battery voltage present at 810 Pnk wire at S4 PTO/RIP switch (I)?

System: PTO Circuit

Yes - Go to next step.

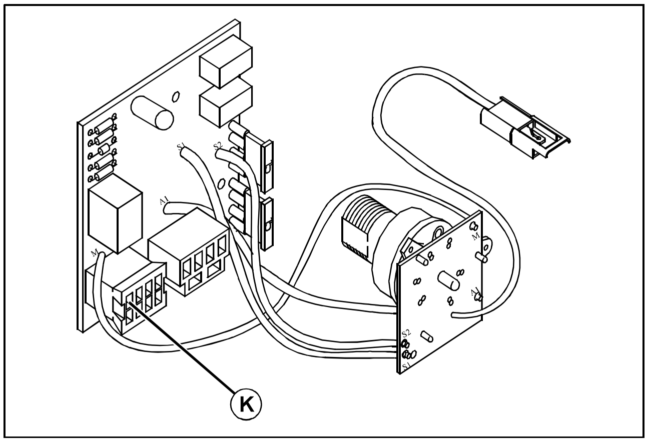
No - Check 810 Pnk wire and connections. If OK, replace PTO/RIP switch.



(10) Is battery voltage present at S3 RIO switch, 710 Pur and 730 Org wires (J)?

Yes - Go to next step.

No - Check 710 Pur and 730 Org wires and connections?

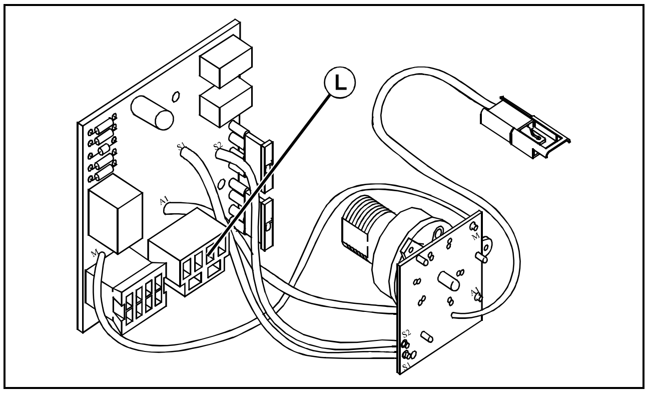


(11) Is battery voltage present at interlock module connector X2, pin A (K)?

Yes - Go to next step.

No - Check 732 Grn wire and connections. If OK, replace RIO switch.

System: PTO Circuit



(12) Is battery voltage present at interlock module connector X3, pin 5? (L)?

Yes - See “Procedure B” on page 304.

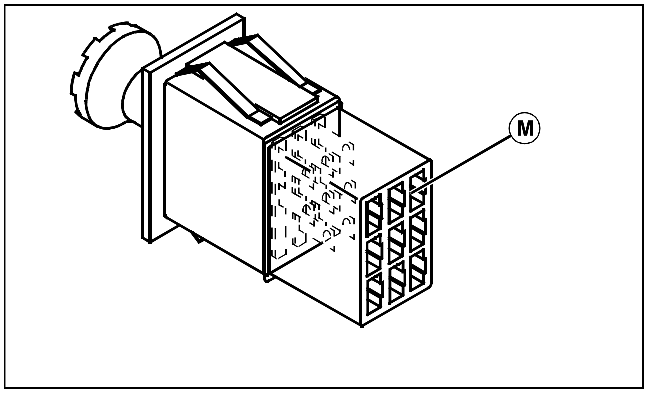
No - Check 750 Pur wire and connections.

Procedure B

Test Conditions:

- Key switch in RUN position - engine NOT running.
- Operator ON seat (Seat switch CLOSED).
- PTO/RIP switch in ON position.

System: PTO Circuit

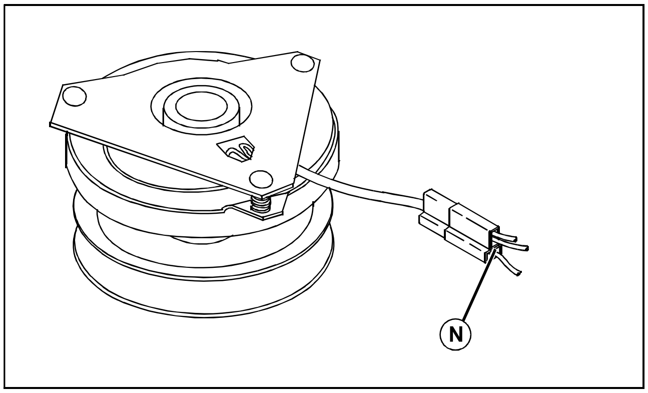


(1) Is battery voltage present at S4 PTO/RIP Switch 750 Pur wire (M)?

Yes - Go to next step.

No - Check 750 Pur wire and connections. If OK, replace PTO/RIO switch.

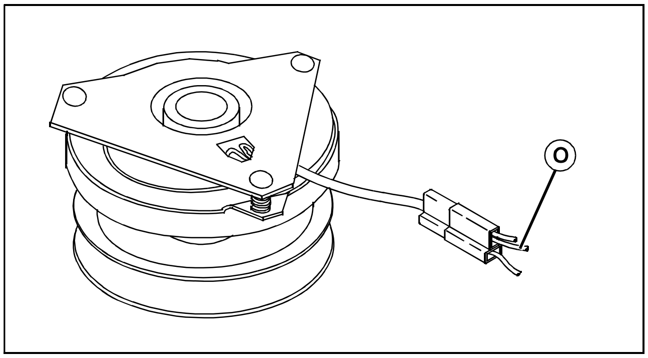
System: PTO Circuit



(2) Is battery voltage present at X6 PTO clutch connector, 500 Blu wire? (N)?

Yes - Go to next step.

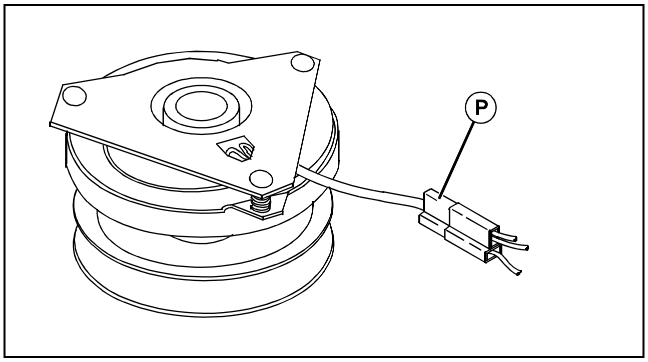
No - Check 500 Blu wire and connections.



(3) Is there continuity to ground at PTO clutch connector X6, 103 Blk wire (O)?

Yes - Go to next step.

No - Check 103 Blk wire and connections.



(4) Unplug X6 connector. Measure resistance across PTO clutch terminals (P). Does the resistance measure between 2.4 - 2.7 ohms?

System: PTO Circuit

No - Replace Y1 PTO clutch.

Reverse Implement Option (RIO) Circuit Operation

Function:

To provide a safety interlock between the machine being operated in reverse while the PTO is engaged, by disengaging the PTO circuit. An operator who deems it necessary, and chooses to keep the PTO engaged while backing up, must take a deliberate action to actuate the PTO/RIP switch, by pulling up on the PTO/RIP switch momentarily while pressing the reverse pedal.

RIO Operating Conditions:

The key switch must be in the RUN position, operator must be ON the seat, and the PTO/RIP switch must be in the RIO (momentary) position while starting operation in reverse.

System Operation:

NOTE: The key switch is connected to the printed circuit board (A1 Interlock Module) by soldered wire connections. Components are solid state and are not serviced separately except for the 15 amp fuses. Lines within dashed border of the Interlock Module (A1) except for key switch connections are circuit paths on the circuit board are not wires in the harness.

The RIO circuit is powered by either the RIO switch or the PTO/RIP switch. With the machine in neutral or forward, the RIO switch supplies power to the PTO relay which in turn supplies power to the PTO/RIP switch to be used when the PTO is engaged. When the machine is operated in reverse the RIO switch is pressed in and its contact open breaking the circuit to the PTO relay. This in turn disengages power to the PTO/RIP switch disengaging the PTO.

The power circuit provides current to the key switch (S1) and protects the system with a 15 amp fuse (F3). Current flows from the battery (G1) positive (+) terminal to the fusible link (F1), 210 Red wire and key switch. With the key switch in the RUN position, current flows through the 15 amp fuse (F3) to the ignition relay N.O. contact terminal, 451, 452, and 414 Yel wires, seat switch (S2) contacts closed (operator on seat), 800 Pnk wire, to the interlock module to energize the ignition relay. With the ignition relay energized, its contacts close and provide power to the PTO relay N.O. contact terminal, 805 Pnk wire, engine connector X4, Grn wire to fuel shutoff solenoid, Grn wire to the voltage regulator/rectifier (N1), 810 Pnk wire and PTO/RIP switch (S4).

The PTO/RIP switch is used in the PTO safety circuit to prevent the PTO relay from energizing if the PTO/RIP switch is in the ON position when the key switch is turned on. With the PTO/RIP switch OFF (PTO disengaged), current flows from the 805 Pnk wire, across the PTO/RIP switch contact to the 710 Pur and 730 Org wires, RIO switch N.C. contacts (neutral or forward position), 732 Grn wire into the interlock module to energize the PTO relay coil and RIO unlatch relay coil. The PTO relay contacts close suppling power to the 750 and 710 Pur wires at the PTO/RIP switch. The 710 Pur wire jumpers back to the interlock module to supply power to the RIO latch relay normally open contact. This then creates a loop to energize the PTO relay. Power is now available at the PTO/RIP switch to energize the RIO circuit and the PTO clutch when the PTO/RIP switch is moved to the ON position.

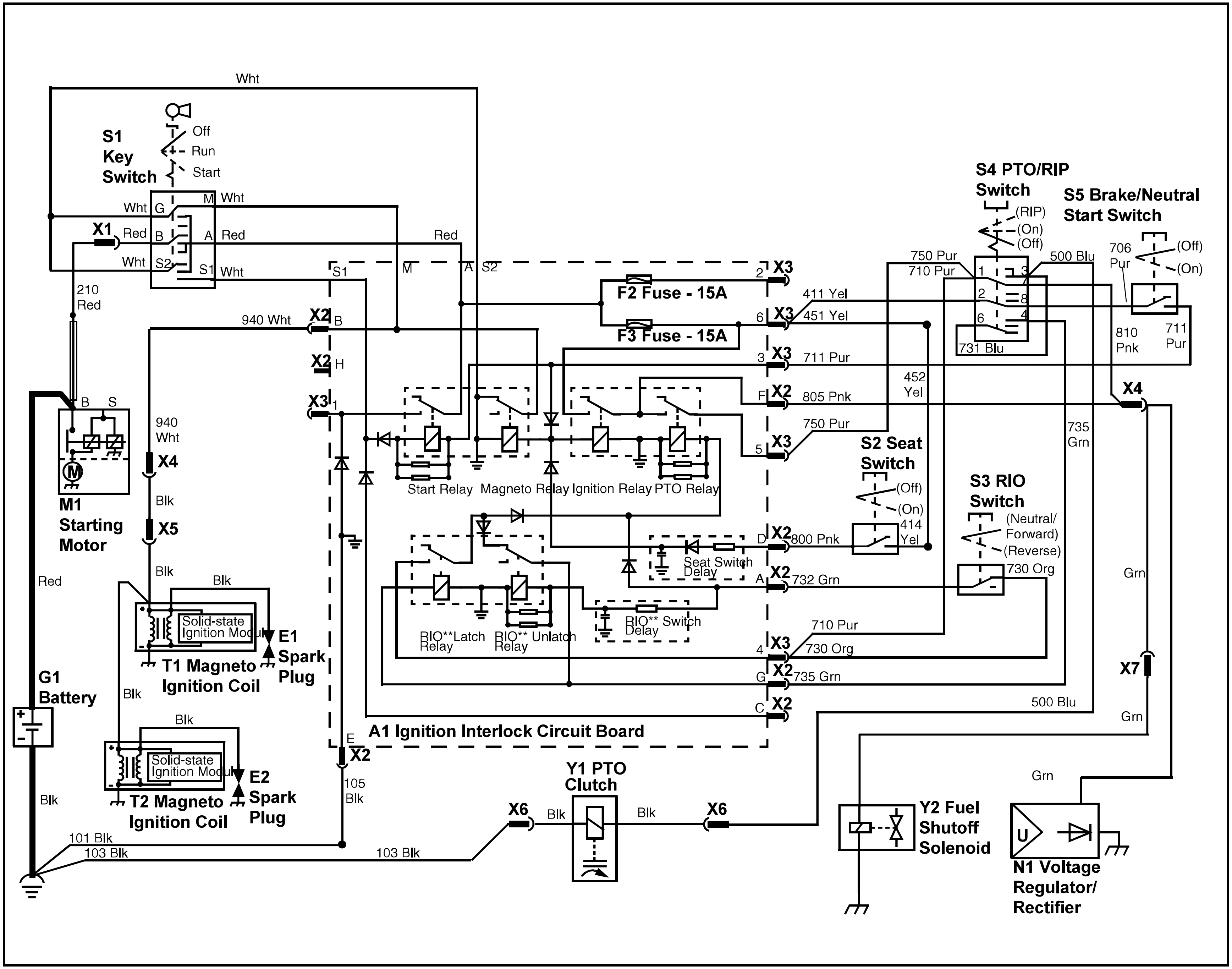
With the PTO/RIP switch in to ON (PTO engaged) position, power is supplied from the 750 Pur wire across the PTO/RIP contacts to the 500 and 731 Blu wires. The 500 Blu wire supplies power to the PTO clutch while the 731 Blu wire jumpers to the common terminal of the PTO/RIP switch momentary (RIP position) contacts.

If the machine is placed in reverse the RIO switch is pushed in and its contacts are opened, breaking the circuit to the PTO relay and the RIO unlatch relay. This in turn breaks the circuit to the 750 Pur wire back to the PTO/RIP switch where it connects to the 710 Pur wire to continue the loop back to the RIO switch. Because the 750 Pur wire is now deenergized, there is no power for the PTO/RIP switch to energize the PTO. To reenergize these circuits, the machine must be place in neutral or forward, and the PTO/RIP switch must be placed in the OFF position. The operator can then energize the PTO again if desired.

If the operator chooses to operate the machine in reverse while the PTO is engaged, the operator must pull up on the PTO/RIP switch while placing the machine in reverse. Once the machine is traveling in reverse the operator can release the PTO/RIP switch. The RIO latch relay feeds itself across the RIO unlatch relay contacts as well as suppling power to the PTO relay and the PTO loop. Power to create this condition comes from the PTO/RIP switch momentary contacts. Wire 731 Blu is connected to wire 735 Grn which connects to the interlock module to energize the RIO latch relay coil. The RIO latch relay takes the place of the RIO switch during reverse operation with the RIP circuit activated.

When the machine is then placed back into neutral or forward, the RIO unlatch relay is energized and breaks the loop to the RIO latch relay. This then prepares the machine for the next reverse operation with the PTO engaged.

RIO Circuit Schematic


S1 Key Switch
Off
Run
Start
G
B
S2
M
A
S1
Wht
Red
Wht
Wht
Red
Wht
X1
210 Red
B
S
M1 Starting Motor
G1 Battery
Red
Blk
101 Blk
103 Blk
103 Blk
940 Wht
X2 B
X2 H
X3 1
940 Wht
X4
Blk
X5
Blk
Blk
Solid-state Ignition Module
E1 Spark Plug
T1 Magneto Ignition Coil
Blk
Blk
Solid-state Ignition Module
E2 Spark Plug
T2 Magneto Ignition Coil
E
X2
105 Blk
S1
M
A
S2
F2 Fuse - 15A
F3 Fuse - 15A
Start Relay
Magneto Relay
Ignition Relay
PTO Relay
Seat Switch Delay
RIO** Switch Delay
RIO**Latch Relay
RIO** Unlatch Relay
A1 Ignition Interlock Circuit Board
2 X3
6 X3
3 X3
F X2
5 X3
D X2
A X2
4 X3
G X2
C X2
411 Yel
451 Yel
711 Pur
805 Pnk
750 Pur
800 Pnk
732 Grn
710 Pur
730 Org
735 Grn
500 Blu
452 Yel
S2 Seat Switch
(Off)
(On)
414 Yel
S3 RIO Switch
(Neutral/ Forward)
(Reverse)
730 Org
735 Grn
S4 PTO/RIP Switch
(RIP)
(On)
(Off)
750 Pur
710 Pur
1
2
6
3
8
4
731 Blu
500 Blu
S5 Brake/Neutral Start Switch
706 Pur
(Off)
(On)
810 Pnk
711 Pur
X4
Grn
X7
Grn
Grn
Y1 PTO Clutch
X6
Blk
Blk
X6
Y2 Fuel Shutoff Solenoid
N1 Voltage Regulator/ Rectifier
U

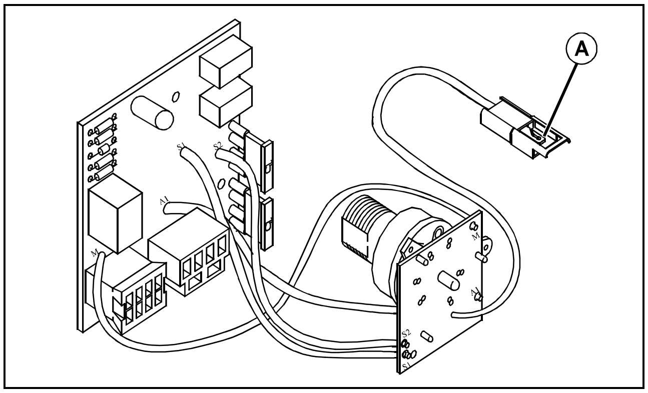
RIO Circuit Diagnosis

Procedure A

Test Conditions:

- Key switch in RUN position - engine NOT running.
- Operator ON seat (Seat switch CLOSED).
- PTO/RIP switch in OFF position.
- Transaxle in NEUTRAL.

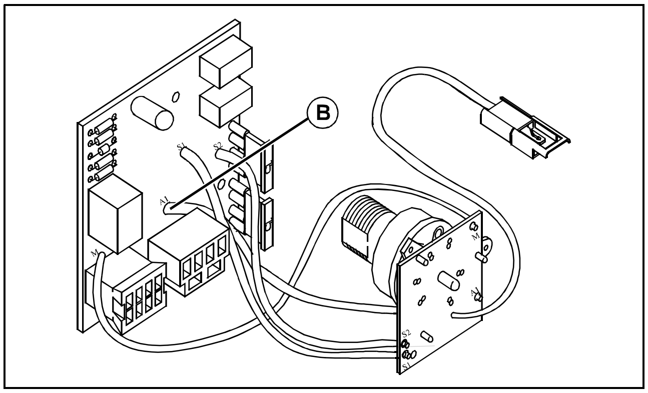
System: RIO Circuit



(1) Is battery voltage present at S1 Key Switch X1 connector (A)?

Yes - Go to next step.

No - Check F1 fusible link, 210 Red wire, X1 connector to key switch and connections.

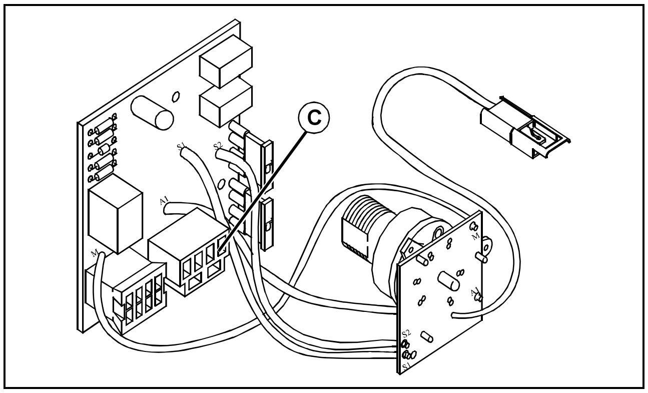


(2) Is battery voltage present at A1 Interlock Module “A” solder joint connection (B)?

Yes - Go to next step.

No - Replace A1 Interlock Module.

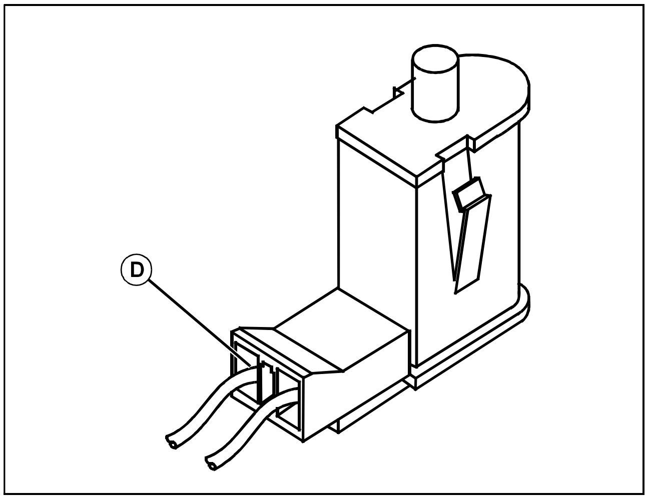
System: RIO Circuit



(3) Is battery voltage present at interlock module X3, pin 6, 451 and 411 Yel wires (C)?

Yes - Go to next step.

No - Replace interlock module.

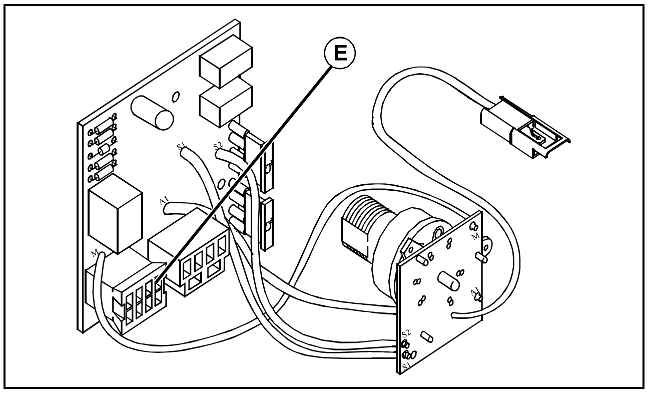


(4) Is battery voltage present at S2 Seat Switch (D)?

Yes - Go to next step.

No - Check 451, 452, and 414 Yel wires and connections.

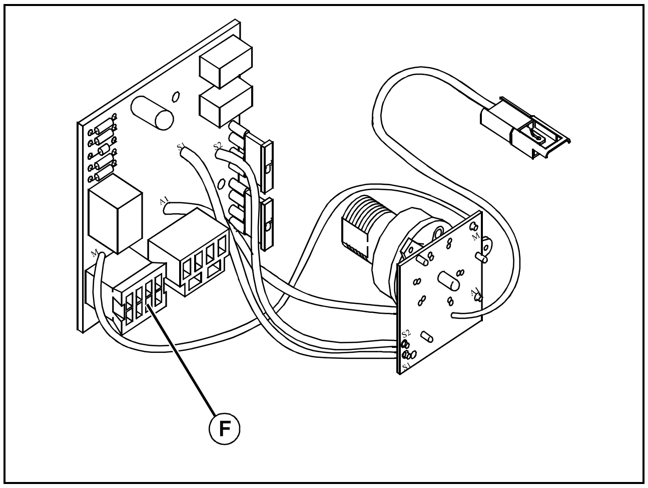
System: RIO Circuit



(5) Is battery voltage present at interlock module connector X2, pin D (E)?

Yes - Go to next step.

No - Check 800 Pnk wire and connections. If OK, replace seat switch.

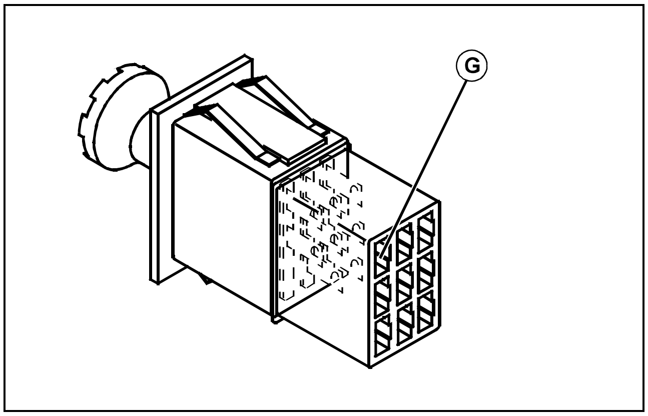


(6) Is battery voltage present at interlock module connector X2, pin F (F)?

Yes - Go to next step.

No - Replace interlock module.

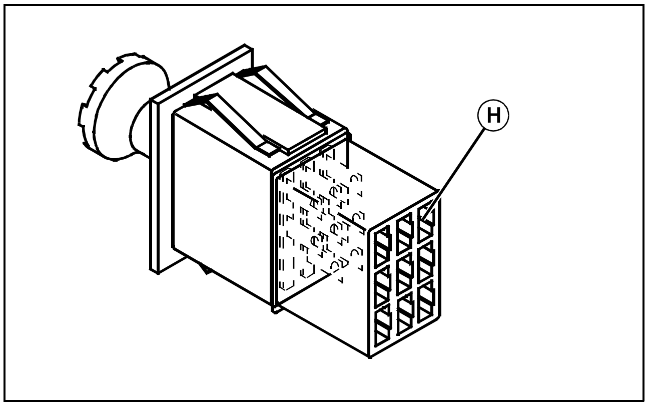
System: RIO Circuit



(7) Is battery voltage present at PTO/RIP switch 805 and 810 Pnk wires (G)?

Yes - Go to next step.

No - Check 805 and 810 Pnk wires and connections. If OK, replace PTO/RIP switch.

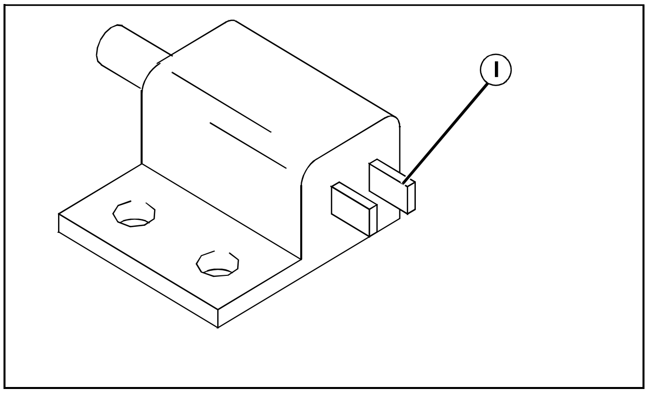


(8) Is battery voltage present at interlock module connector X2, pin A (H)?

Yes - Go to next step.

No - Check 710 Pur wire and connections.

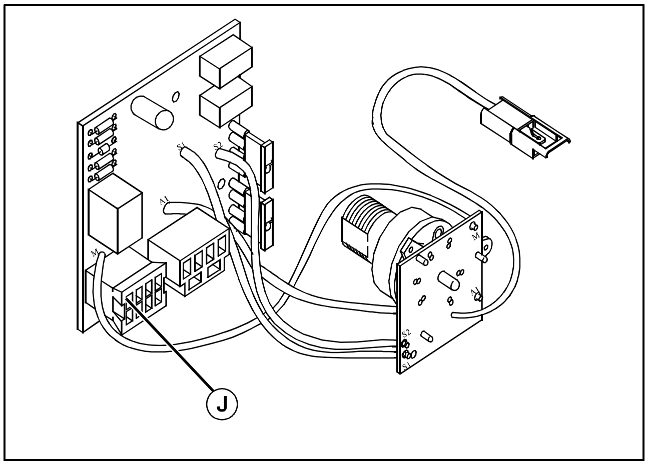
System: RIO Circuit



(9) Is battery voltage present at RIO switch 730 Org wire (I)?

Yes - Go to next step.

No - Check 730 Org wire and connections.

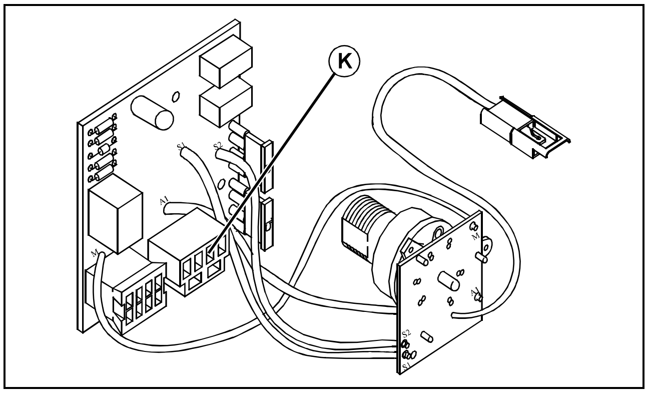


(10) Is battery voltage present at interlock module connector X2, pin A (J)?

Yes - Go to next step.

No - Check 732 Grn wire and connections. If OK, replace RIO switch.

System: RIO Circuit



(11) Is battery voltage present at interlock module connector X3, pin 5 (K)?

Yes - See “Procedure B” on page 310.

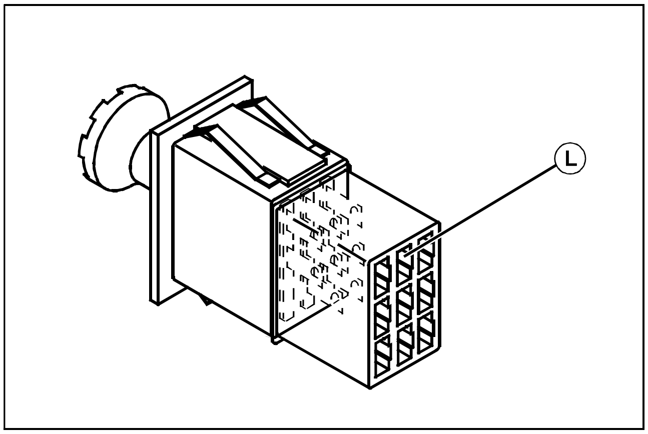
No - Check 750 Pur wire and connections.

Procedure B

Test Conditions:

- Key switch in RUN position - engine NOT running.
- PTO/RIP switch in MOMENTARY (RIP) position.
- Operator ON seat.
- Operator ON seat (Seat switch CLOSED).
- Transaxle in REVERSE.

System: RIO Circuit

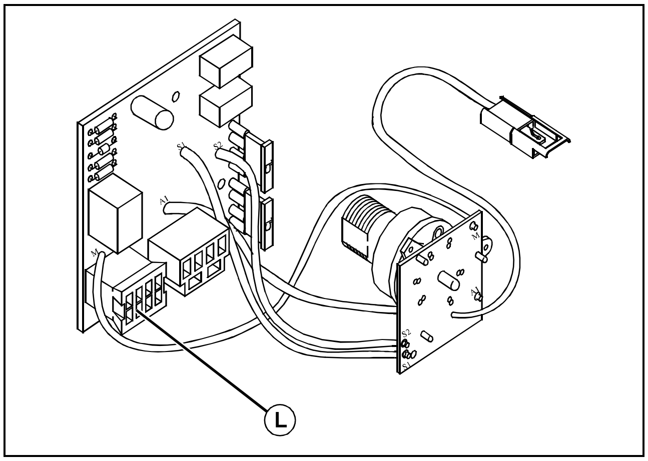


(1) Is battery voltage present at PTO/RIO switch 731 Blu wire (L)?

Yes - Go to next step.

No - Check 731 Blu wire and connections. If OK, replace PTO/RIO switch.

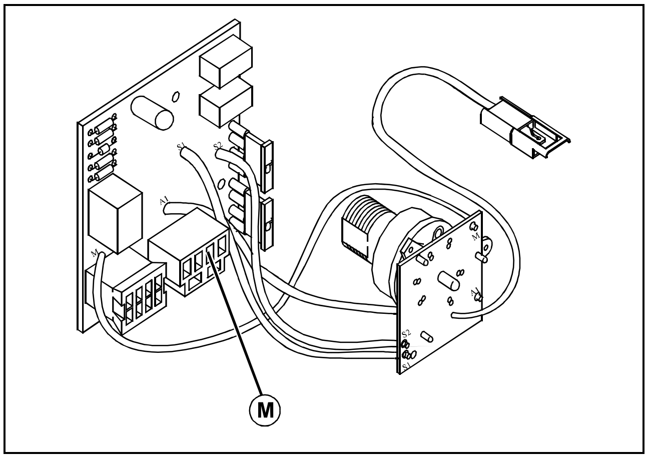
System: RIO Circuit



(2) Is battery voltage present at interlock module connector X2, pin G (L)?

Yes - Go to next step.

No - Check 735 Grn wire and connections. If OK, replace PTO/RIO switch.



(3) Is battery voltage present at interlock module connector X3, pin 5 (M)?

No - Replace interlock module.

Low Oil Pressure Light Circuit Operation

Function:

To light the low oil pressure light to alert the operator that the oil pressure is too low for continued operation.

Operating Conditions:

- Key switch in RUN position.
- Oil pressure switch closed. (Engine OFF or low oil pressure.).

System Operation:

NOTE: The key switch is connected to the printed circuit board (A1 Interlock Module) by soldered wire connections. Components are solid state and are not serviced separately except for the 15 amp fuses. Lines within dashed border of the Interlock Module (A1) except for key switch connections are circuit paths on the circuit board are not wires in the harness.

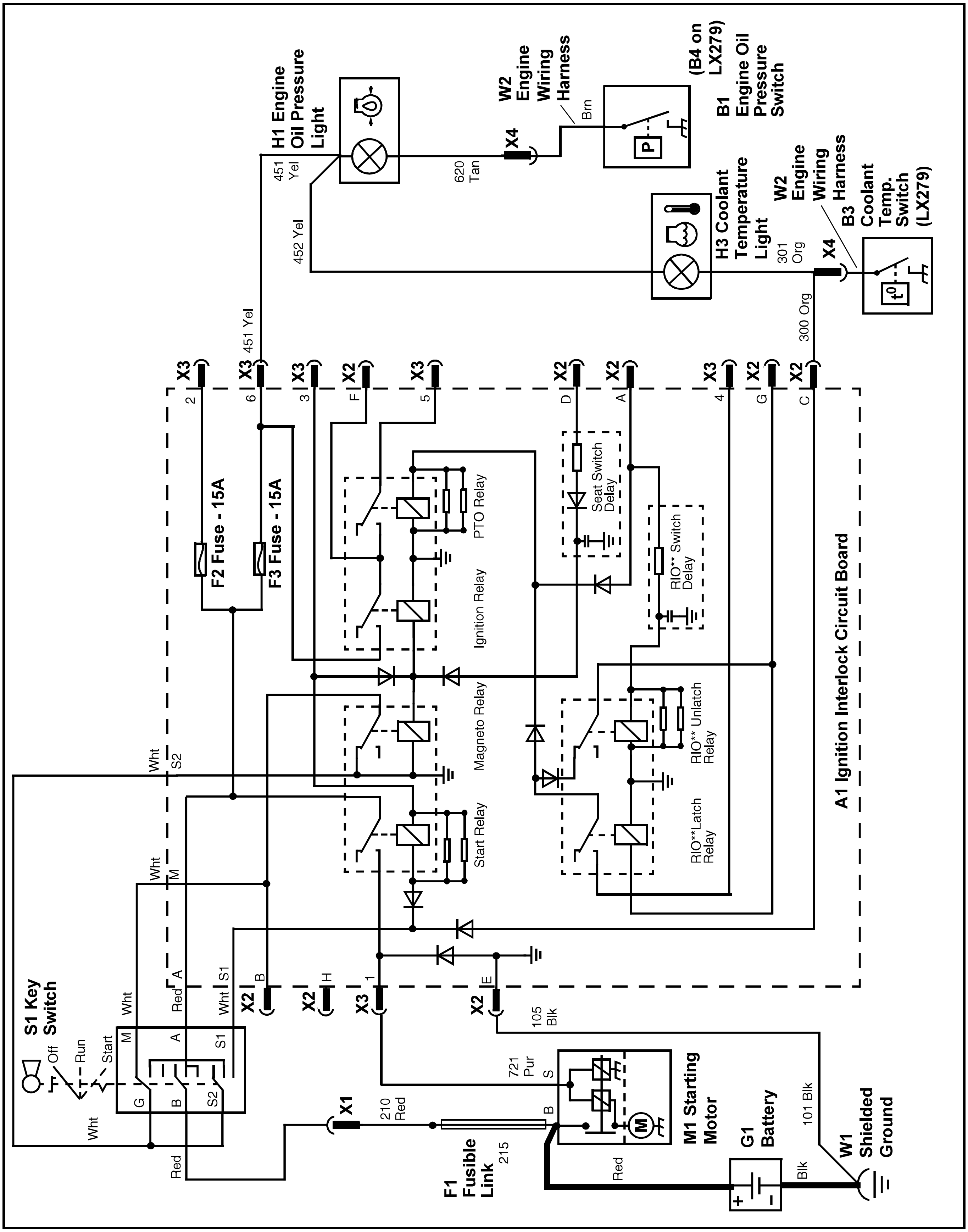
The low oil pressure light system uses a pressure activated switch to provide a path to ground for the oil pressure light. The switch is closed when engine oil pressure is at or below 28 kPa (4 psi).

The power circuit provides current to the key switch (S1) and protects the low oil pressure light circuit with a 15 amp fuse (F3). Current flows from the battery (G1) positive (+) terminal to the fusible link (F1) and key switch. With the key switch in the RUN position, current flows to the 15 amp fuse (F3), 451 Yel wire and the oil pressure light (H1).

If the engine is not running or oil pressure is at or below 28 kPa (4 psi), the oil pressure switch (B1) will be closed. The oil pressure switch completes the path to ground and the low oil pressure light comes ON. When the engine starts and oil pressure increases above 28 kPa (4 psi), the oil pressure switch opens, breaking the path to ground and the light goes out.

The ground circuit provides a path to ground through the oil pressure switch and the 101 Blk wire for the oil pressure light.

Low Oil Pressure Schematic


H1 Engine Oil Pressure Light
W2 Engine Wiring Harness
(B4 on LX279)
B1 Engine Oil Pressure Switch
Brn
620 Tan
X4
451 Yel
452 Yel
H3 Coolant Temperature Light
W2 Engine Wiring Harness
B3 Coolant Temp. Switch (LX279)
301 Org
X4
300 Org
451 Yel
X3 2
X3 6
X3 3
X2 F
X3 5
X2 D
X2 A
X3 4
X2 G
X2 C
F2 Fuse - 15A
F3 Fuse - 15A
PTO Relay
Ignition Relay
Seat Switch Delay
RIO** Switch Delay
Magneto Relay
Start Relay
RIO** Unlatch Relay
RIO**Latch Relay
A1 Ignition Interlock Circuit Board
Wht S2
Wht M
Red A
Wht S1
X2 B
X2 H
X3 1
X2 E
S1 Key Switch
Off
Run
Start
M
A
S1
G
B
S2
Wht
Wht
Red
105 Blk
721 Pur
S
B
M1 Starting Motor
X1
210 Red
F1 Fusible Link
215
Red
G1 Battery
101 Blk
Blk
W1 Shielded Ground

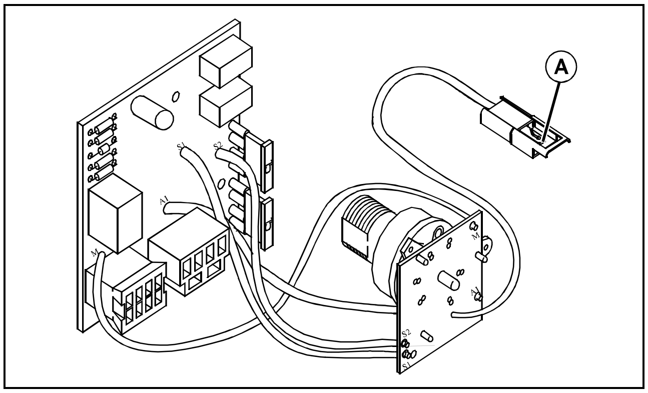
Low Oil Pressure Circuit Diagnosis

Procedure A

Test Conditions:

- Key switch in RUN position - engine NOT running.
- Engine oil pressure switch lead disconnected.

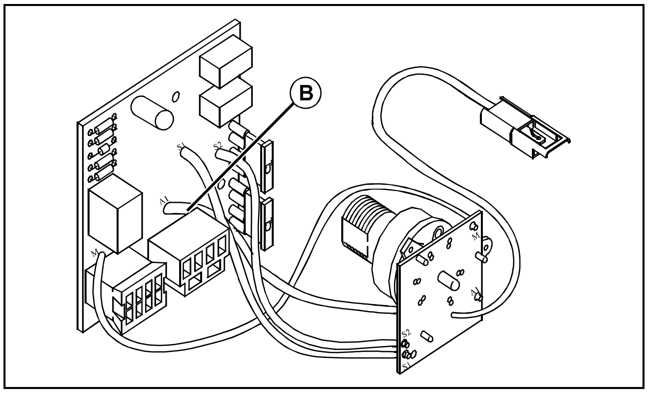
System: Low Oil Pressure Circuit



(1) Is battery voltage present at S1 Key Switch X1 connector (A)?

Yes - Go to next step.

No - Check 210 Red wire, F1 fusible link, X1 connector to key switch, and connections.

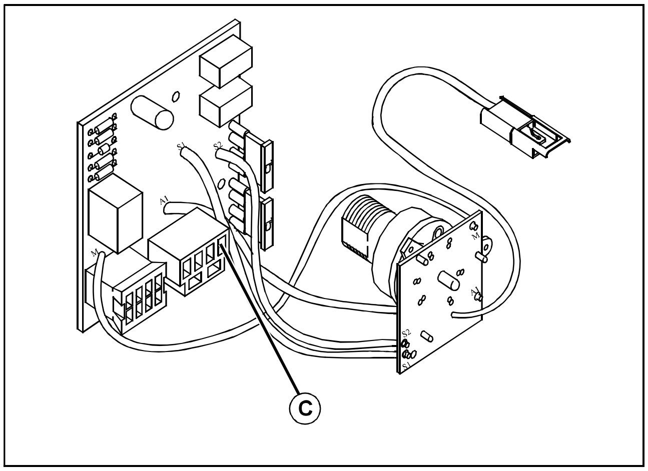


(2) Is battery voltage present at A1 Interlock Module "A" solder joint connection (B)?

Yes - Go to next step.

No - Replace interlock module.

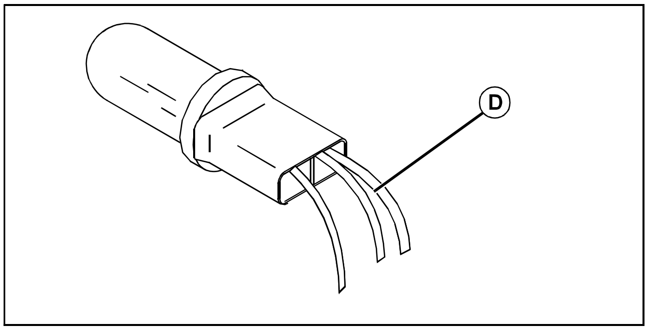
System: Low Oil Pressure Circuit



(3) Is battery voltage present at interlock module connector X3, pin 6 (C)?

Yes - Go to next step.

No - Check F3 fuse. If OK, replace interlock module.

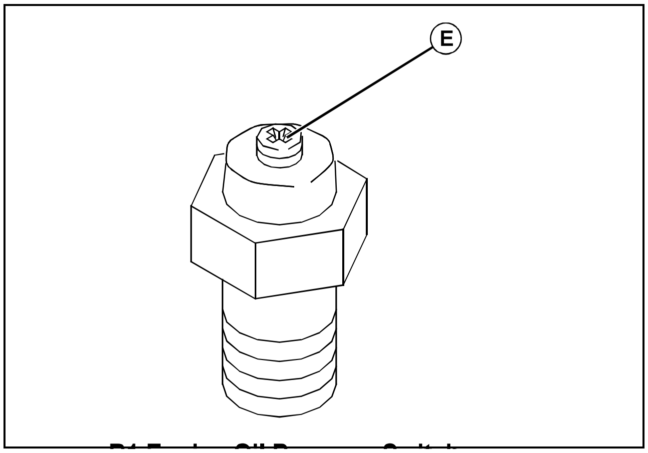


(4) Is battery voltage present at H1 Engine Oil Pressure Light, 451Yel wire (D)?

Yes - Go to next step.

No - Check 451 Yel wire and connections.

System: Low Oil Pressure Circuit



(5) Is battery voltage present at engine oil pressure light lead 620 Tan wire (E)?

Yes - See “Procedure B” on page 315.

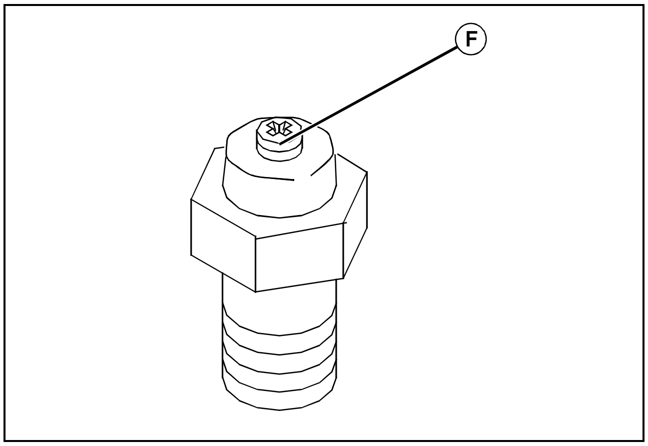
No - Check 620 Tan wire and connections. If OK, replace engine oil pressure light.

Procedure B

Test Conditions:

- Key switch in OFF position.

System: Low Oil Pressure Circuit



(1) Is there continuity to ground at B1 Engine Oil Pressure Switch lead (F) with a maximum of 0.1 ohms of resistance?

Yes - See “Procedure C” on page 315.

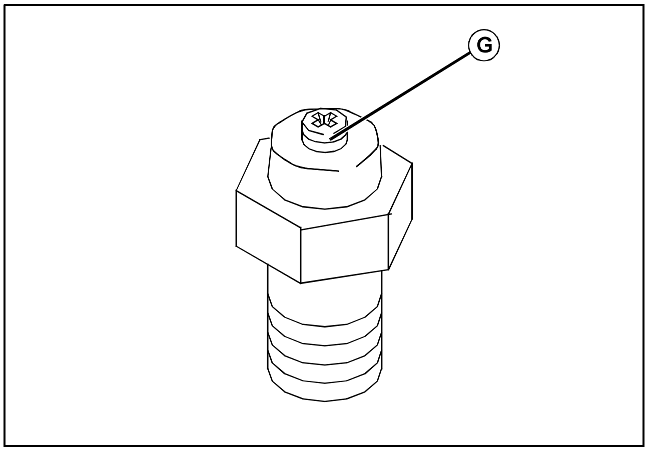
No - Replace engine oil pressure switch.

Procedure C

Test Conditions:

- Key switch in RUN position - engine running.

System: Low Oil Pressure Circuit



(1) Is there no continuity to ground at engine oil pressure switch lead (G)?

No - Check engine oil pressure. If OK, replace engine oil pressure switch.

Headlight Circuit Operation

Function:

To provide power to the headlights for illumination if desired by the operator.

Operating Conditions

- Key switch in RUN position.
- Headlight switch in ON position.

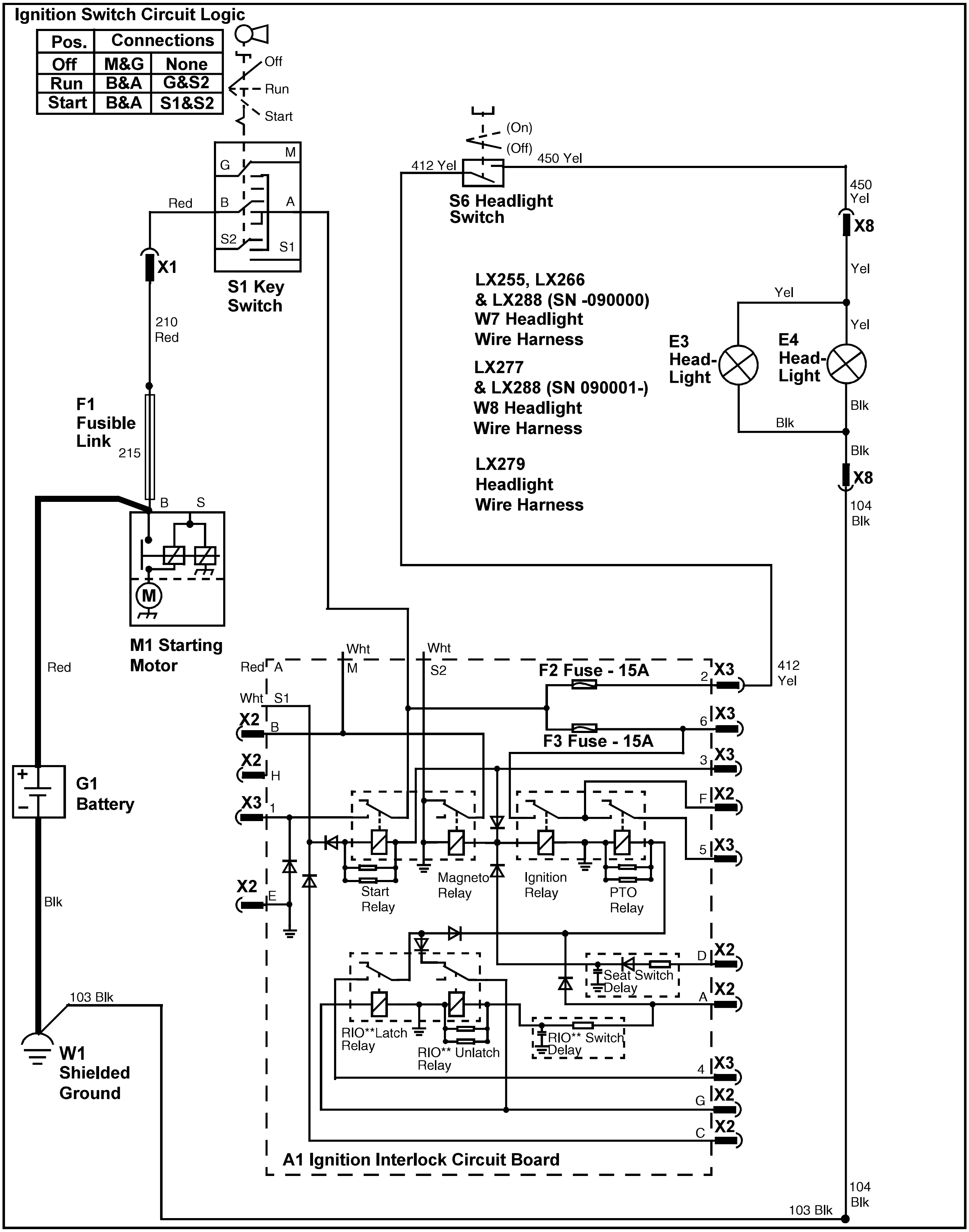
System Operation:

NOTE: The key switch is connected to the printed circuit board (A1 Interlock Module) by soldered wire connections. Components are solid state and are not serviced separately except for the 15 amp fuses. Lines within dashed border of the Interlock Module (A1) except for key switch connections are circuit paths on the circuit board are not wires in the harness.

he power circuit provides current to the key switch (S1) and protects the circuit with a 15 amp fuse (F2). With the key switch in the RUN position, current flows from the battery (G1) positive (+) terminal to the fusible link (F1), key switch, 15 amp fuse (F2), 412 Yel wire and headlight switch (S6). With the headlight switch in the ON position, current flows to the 450 Yel wire X8 connector, Yel wire, headlights (E3 and E4) and illuminates the lamps.

The ground circuit provides a path to ground for the headlight through wires 104 and 103 Blk.

Headlight Circuit Schematic



Ignition Switch Circuit Logic

Pos.	Connections	
Off	M&G	None
Run	B&A	G&S2
Start	B&A	S1&S2

Off
Run
Start
G
M
Red
B
A
S2
S1
S1 Key Switch
X1
210 Red
F1 Fusible Link
215
B
S
M
M1 Starting Motor
Red
G1 Battery
Blk
103 Blk
W1 Shielded Ground
(On)
(Off)
412 Yel
450 Yel
S6 Headlight Switch
450 Yel
X8
Yel
Yel
Yel
E3 Head-Light
E4 Head-Light
Blk
Blk
Blk
X8
104 Blk
LX255, LX266 & LX288 (SN -090000) W7 Headlight Wire Harness
LX277 & LX288 (SN 090001-) W8 Headlight Wire Harness
LX279 Headlight Wire Harness
Red A
Wht S1
Wht M
Wht S2
X2 B
X2 H
X3 1
X2 E
F2 Fuse - 15A
F3 Fuse - 15A
X3 2
412 Yel
X3 6
X3 3
X2 F
X3 5
Start Relay
Magneto Relay
Ignition Relay
PTO Relay
X2 D
Seat Switch Delay
X2 A
RIO**Latch Relay
RIO** Unlatch Relay
RIO** Switch Delay
X3 4
X2 G
X2 C
A1 Ignition Interlock Circuit Board
104 Blk
103 Blk

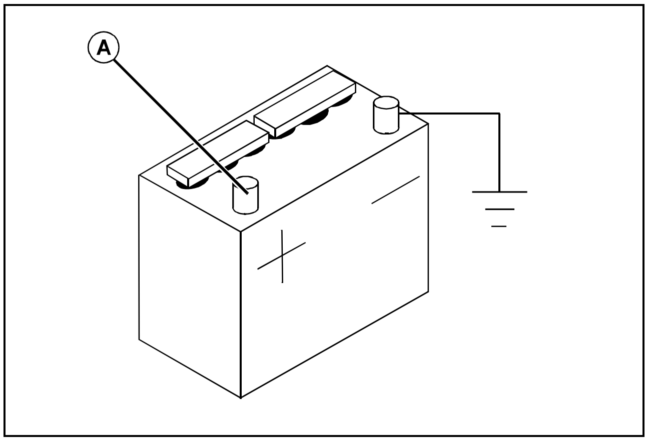
Headlight Circuit Diagnosis

Procedure A

Test Conditions:

- Key switch in RUN position - engine NOT running.
- Headlight switch in ON position.

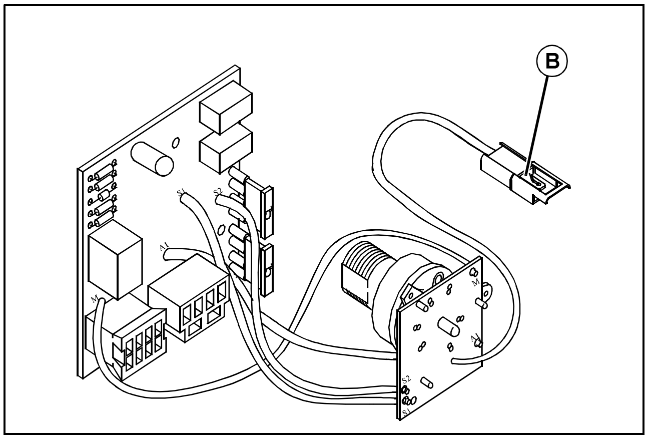
System: Headlight Circuit



(1) Is battery voltage present at battery positive (+) terminal (A)?

Yes - Go to next step?

No - Test battery. See “Battery Voltage and Specific Gravity Test” on page 330.

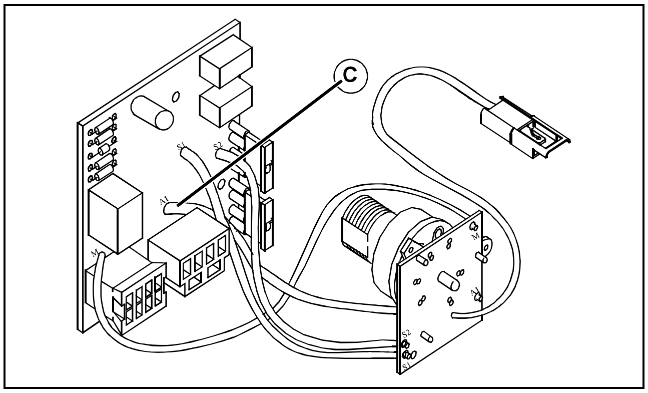


(2) Is battery voltage present at S1 Key Switch X1 connector (B)?

Yes - Go to next step.

No - Check fusible link (F1), 210 Red wire, X1 connector to key switch and connections.

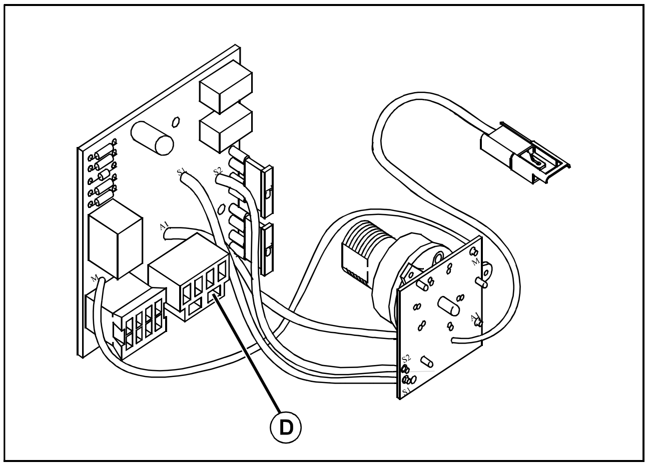
System: Headlight Circuit



(3) Is battery voltage present at A1 Interlock Module “A” solder joint connection (C)?

Yes - Go to next step.

No - Replace interlock module.

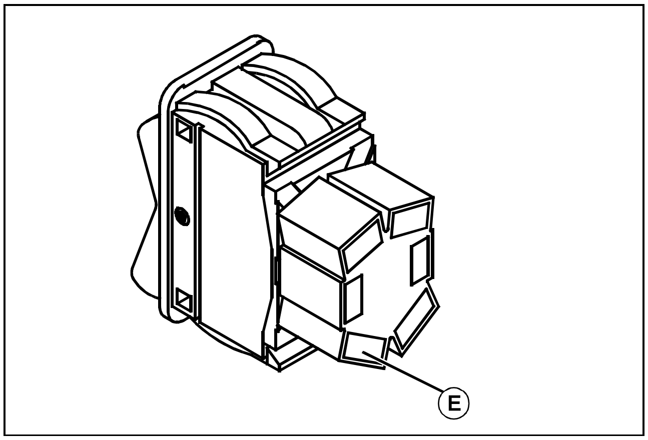


(4) Is battery voltage present at interlock module connector X3, pin 2 (D)?

Yes - Go to next step.

No - Check F2 fuse. If OK, replace interlock module.

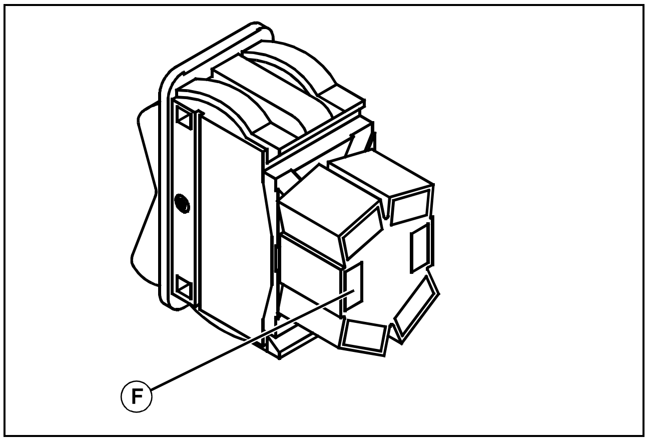
System: Headlight Circuit



(5) Is battery voltage present at S6 headlight Switch 412 Yel wire (E)?

Yes - Go to next step.

No - Check 412 Yel wire and connections.

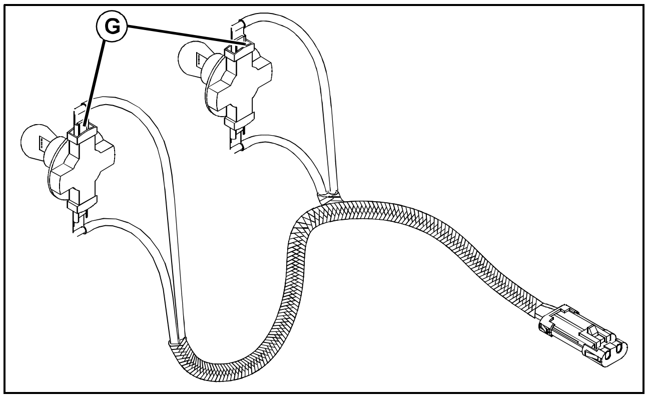


(6) Is battery voltage present at 450 Yel wire (F) at headlight switch?

Yes - Go to next step.

No - Replace headlight switch.

System: Headlight Circuit



(7) Is battery voltage present at X9 headlight wiring harness connectors (G)?

No - Check 450 Yel wire and connections.

Yes - Check W8 Headlight wiring harness and connections.

Yes - Go to next step.

(8) Are the headlights ON?

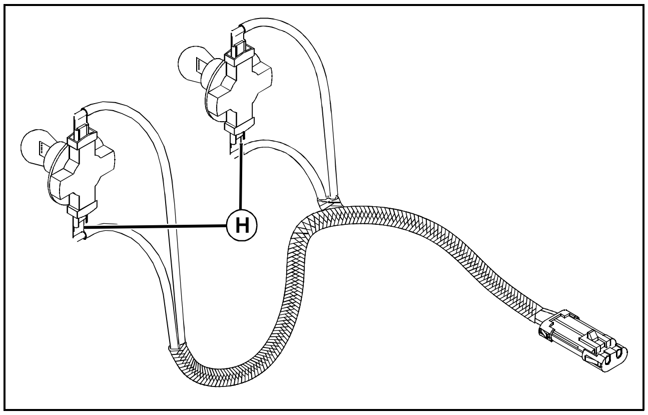
No - See “Procedure B” on page 319.

Procedure B

Test Conditions:

- Key switch in OFF position.

System: Headlight Circuit



(1) Is there a maximum of 0.1 ohms resistance between battery negative (-) terminal and 103 Blk wire at headlights (H)?

No - Check 103 Blk wire shielded ground circuit and connections.

Fuel Shutoff Solenoid Circuit Operation

Reason:

To energized the fuel shutoff solenoid when the ignition relay is energized.

Operating Conditions

- Key switch in START or RUN position.
- Operator on seat. (Seat switch CLOSED.)

or,

- PTO/RIP switch in OFF position.
- Parking brake locked. (Brake/Neutral start switch CLOSED.)

System Operation:

NOTE: The key switch is connected to the printed circuit board (A1 Interlock Module) by soldered wire connections. Components are solid state and are not serviced separately except for the 15 amp fuses. Lines within dashed border of the Interlock Module (A1) except for key switch connections are circuit paths on the circuit board are not wires in the harness.

The fuel shutoff solenoid (Y2) uses an electro-magnetic coil to operate a plunger. The fuel shutoff solenoid plunger stops fuel flow in the carburetor bowl when the solenoid is de-energized. The ignition relay provides power to the fuel shutoff solenoid. When the ignition relay is de-energized, the fuel shutoff solenoid stops fuel flow at the same time the spark is stopped, helping to prevent backfire or afterfire at engine shutdown.

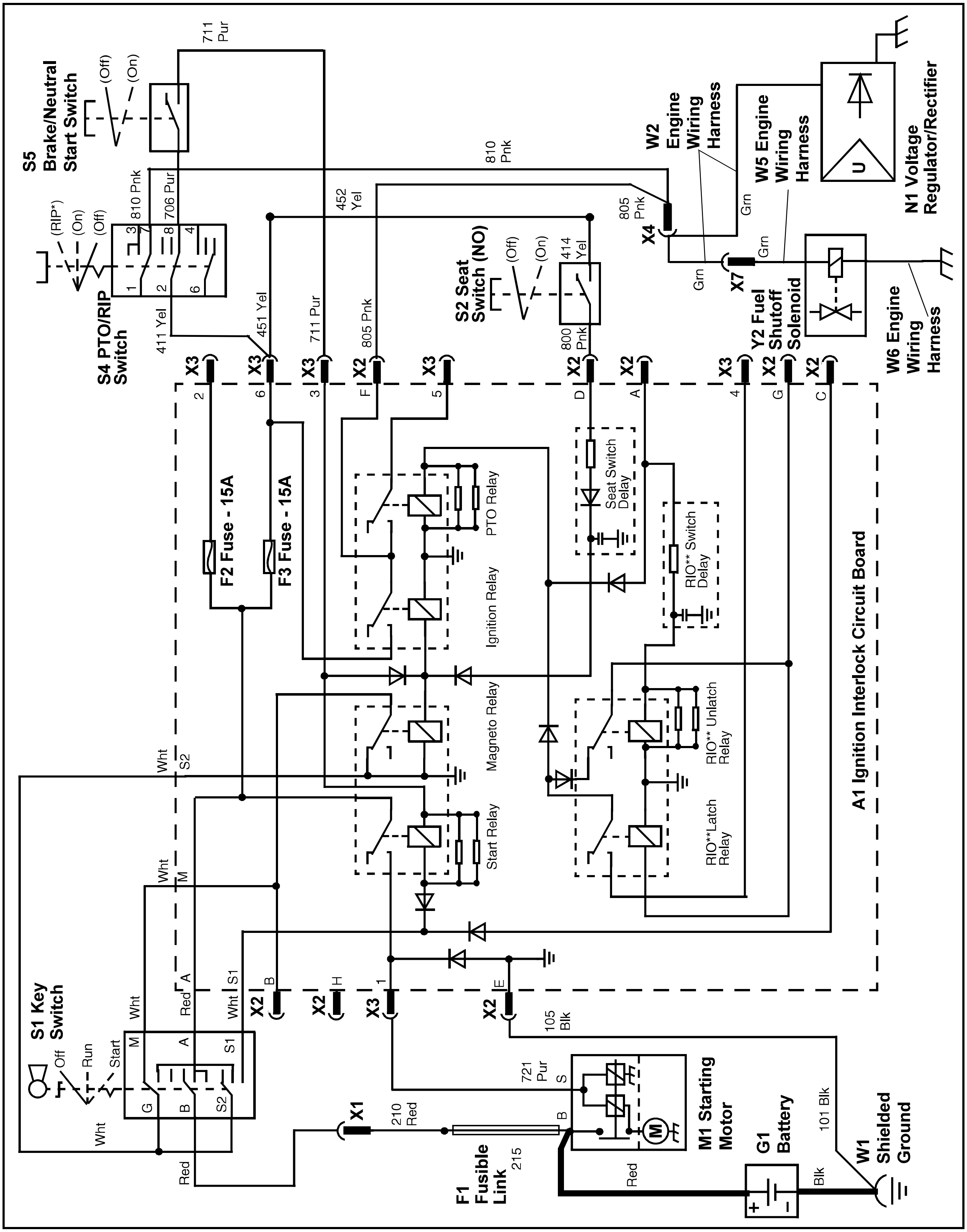
Current cannot flow to the fuel shutoff solenoid until the ignition relay is energized. The ignition relay coil is energized by current from the seat switch circuit or neutral start circuit.

Current flows from the battery (G1) positive (+) terminal to the fusible link (F1), and key switch. With the key switch in the RUN position, current flows to the 15 amp fuse (F3), ignition relay N.O. terminal, 411 and 451 Yel wires. The 411 Yel wire provides current to the PTO/RIP switch (S4), 706 Pur wire, brake/neutral start switch (S5), 711 Pur wire to the interlock module to energize the ignition relay during the neutral or starting operation. The 451 Yel wire provides current to the 452 and 414 Yel wires, seat switch (S2) (contacts closed), 800 Pnk wire to the interlock module to energize the ignition relay during normal operation.

Once the ignition relay is energized and its contact close, current is provided to the 805 Pnk wire, X4 connector, Grn wires of the engine wiring harness (W2) and the fuel shutoff solenoid (Y2).

The ground path for the fuel shutoff solenoid is provided through the frame to the W1 shielded ground.

Fuel Shutoff Solenoid Circuit Schematic


S5 Brake/Neutral Start Switch
(Off)
(On)
711 Pur
810 Pnk
706 Pur
S4 PTO/RIP Switch
(RIP*)
(On)
(Off)
411 Yel
451 Yel
711 Pur
805 Pnk
452 Yel
810 Pnk
805 Pnk
S2 Seat Switch (NO)
414 Yel
800 Pnk
W2 Engine Wiring Harness
W5 Engine Wiring Harness
N1 Voltage Regulator/Rectifier
U
X4
X7
Grn
Y2 Fuel Shutoff Solenoid
W6 Engine Wiring Harness
X3
X2
F2 Fuse - 15A
F3 Fuse - 15A
PTO Relay
Ignition Relay
Magneto Relay
Start Relay
Seat Switch Delay
RIO** Switch Delay
RIO** Unlatch Relay
RIO**Latch Relay
A1 Ignition Interlock Circuit Board
S1 Key Switch
Off
Run
Start
M
A
S1
G
B
S2
Wht
Red
X1
210 Red
F1 Fusible Link
215
721 Pur
S
B
M1 Starting Motor
G1 Battery
105 Blk
101 Blk
Blk
W1 Shielded Ground

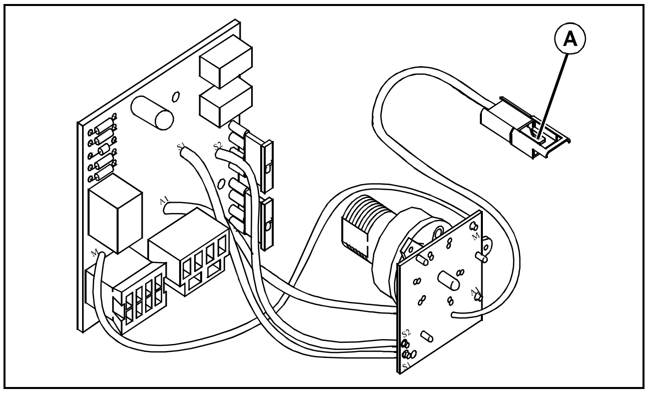
Fuel Shutoff Solenoid Circuit Diagnosis

Procedure A

Test Conditions:

- Key switch in RUN position - engine NOT running.
- PTO/RIP switch OFF.
- Parking brake locked (Brake/Neutral start switch CLOSED).
- Operator OFF seat (Seat switch OPEN).

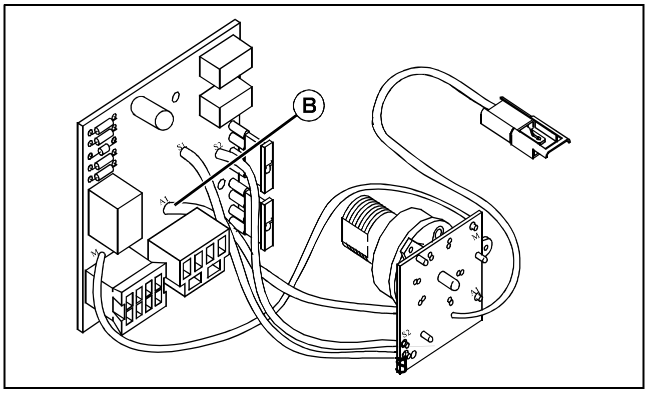
System: Fuel Shutoff Solenoid Circuit



(1) Is battery voltage present at S1 Key Switch X1 connector? (A)?

Yes - Go to next step.

No - Check F1 fusible link, 210 Red wire, X1 connector to key switch, and connections.

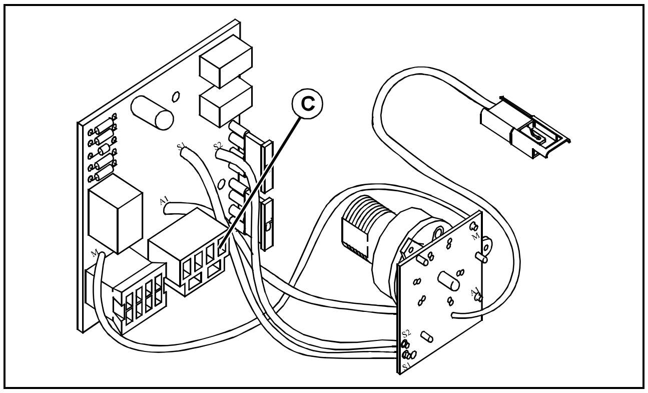


(2) Is battery voltage present at A1 Interlock Module "A" solder connection?

Yes - Go to next step.

No - Replace interlock module.

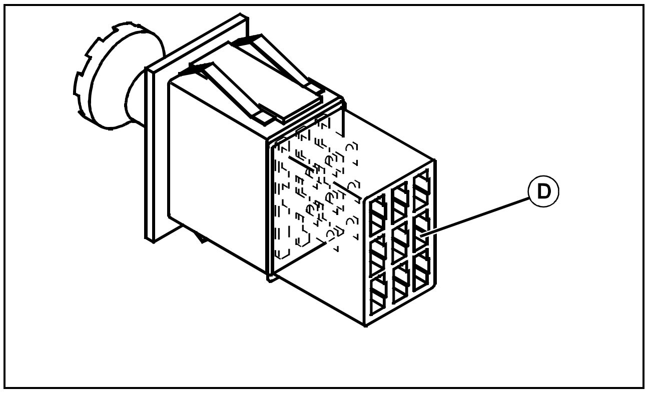
System: Fuel Shutoff Solenoid Circuit



(3) Is battery voltage present at interlock module connector X3, pin 6 (C)?

Yes - Go to next step.

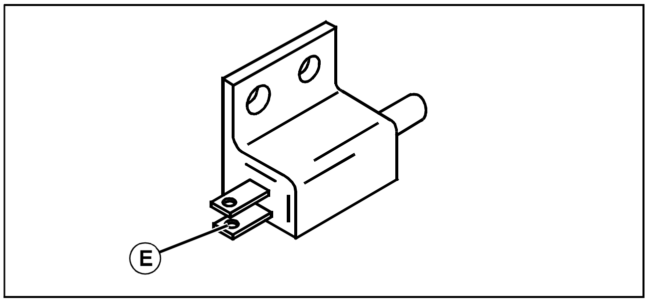
No - Check F3 fuse. If OK, replace interlock module.



(4) Is battery voltage present at S4 PTO/RIO switch 411 Yel wire (D)?

Yes - Go to next step.

No - Check 411 Yel wire and connections.

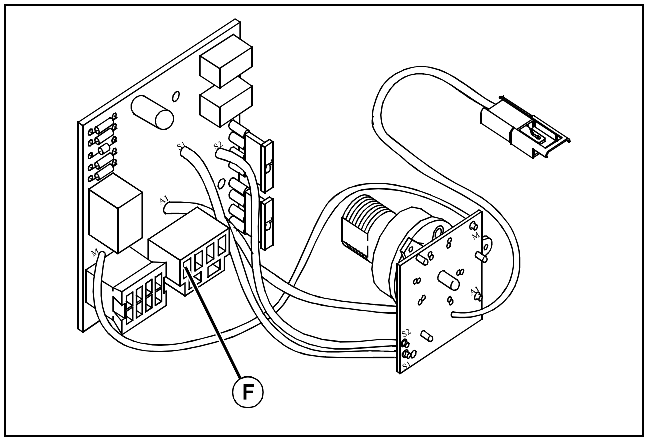


(5) Is battery voltage present at S5 Brake/Neutral start switch 706 Pur wire (E)?

Yes - Go to next step.

System: Fuel Shutoff Solenoid Circuit

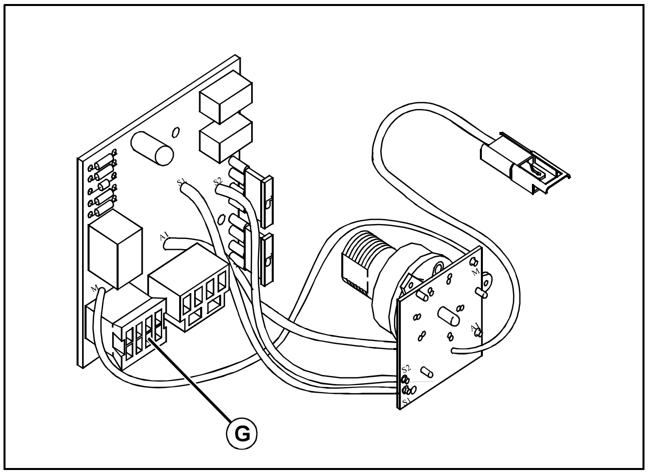
No - Check 706 Pur wire and connections. If OK, replace PTO/RIO switch.



(6) Is battery voltage present at interlock module connector X3, pin 3 (F)?

Yes - Go to next step.

No - Check 711 Pur wire and connections. If OK, replace brake/neutral start switch.



(7) Is battery voltage present at interlock module connector X2, pin F (G)?

Yes - See "Procedure B" on page 323.

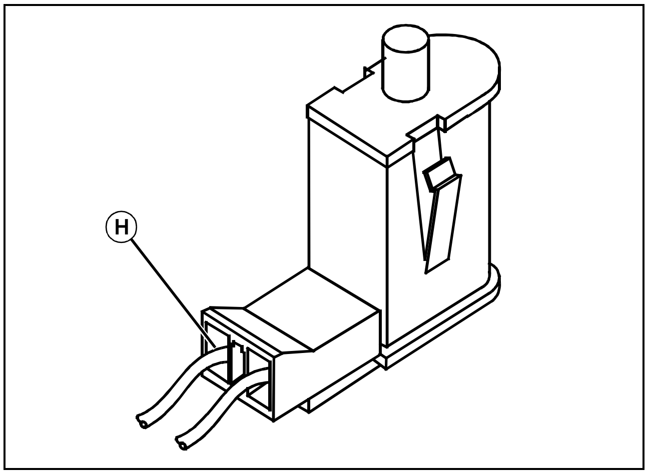
No - Replace interlock module.

Procedure B

Test Conditions:

- Key switch in RUN position.
- PTO/RIP switch OFF.
- Parking brake OFF (Brake/Neutral start switch OPEN).
- Operator on seat (Seat switch CLOSED).

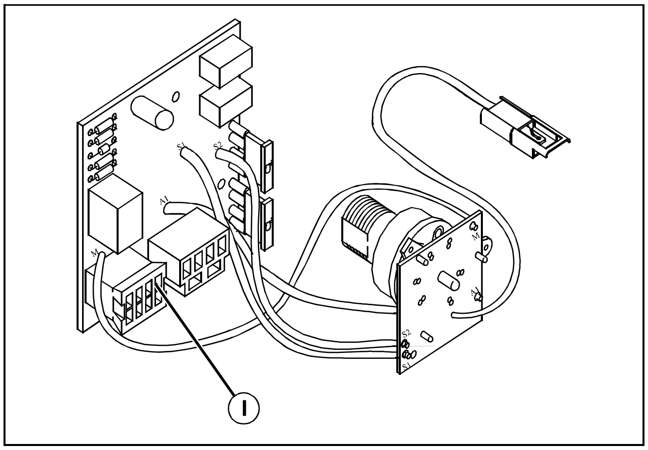
System: Fuel Shutoff Solenoid Circuit



(1) Is battery voltage present at S2 Seat Switch 414 Yel wire (H)?

Yes - Go to next step.

No - Check 414 Yel wire and connections.

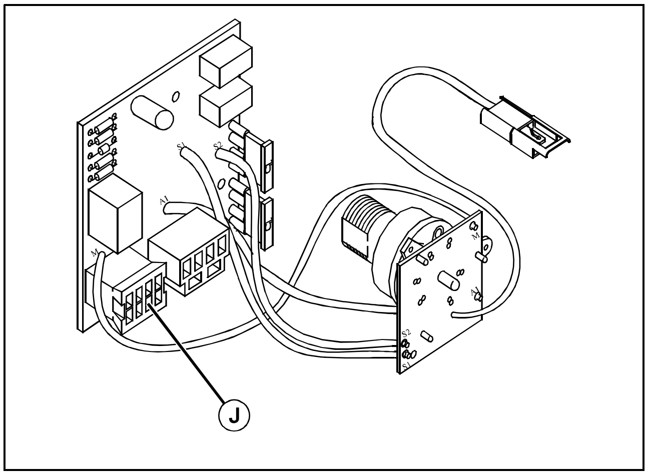


(2) Is battery voltage present at interlock module connector X2, pin D (I)?

Yes - Go to next step.

No - Check 800 Pnk wire and connections. If OK, replace seat switch.

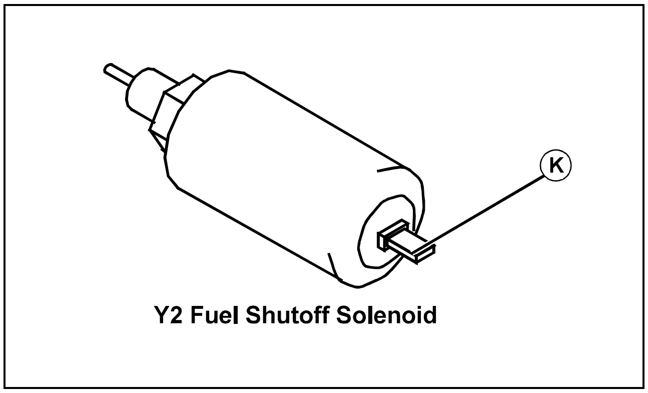
System: Fuel Shutoff Solenoid Circuit



(3) Is battery voltage present at interlock module connector X2, pin F (J)?

Yes - Go to next step.

No - Replace interlock module.



Y2 Fuel Shutoff Solenoid

(4) Is battery voltage present at Y2 Fuel Shutoff Solenoid Grn wire (K)?

Yes - See “Procedure C” on page 324.

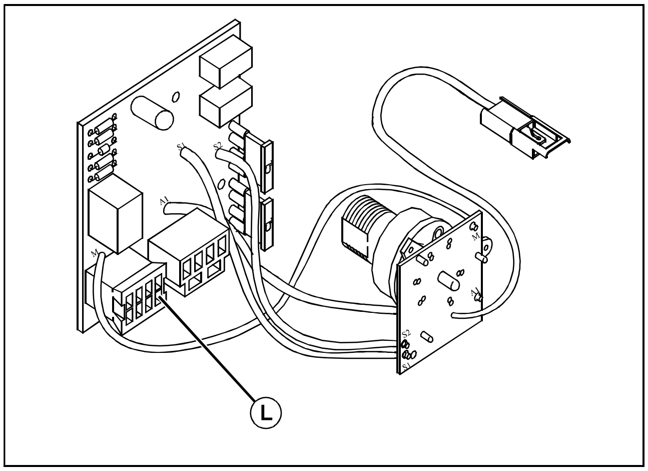
No - Check 805 Pnk wire, W4 engine wiring harness, Grn wire and connections. Check ground circuit. If OK, replace fuel shutoff solenoid.

Procedure C

Test Conditions:

- Key switch in OFF position.

System: Fuel Shutoff Solenoid Circuit



(1) Is the resistance measured between interlock module connector X2, pin E (L) and ground 0.1 ohms or less?

No - Check battery negative (-) cable, shielded ground circuit, and 101 and 105 Blk wires.

Coolant Temperature Light Circuit Operation - LX279

Reason:

To light the coolant temperature light to alert the operator that the engine coolant temperature exceeds normal operating temperature.

Operating Conditions:

- Key switch in START position.

or,

- Key switch in RUN position.
- Engine coolant switch CLOSED. (High coolant temperature.)

Theory of Operation:

NOTE: The key switch is connected to the printed circuit board (A1 Interlock Module) by soldered wire connections. Components are solid state and are not serviced separately except for the 15 amp fuses. Lines within dashed border of the Interlock Module (A1) except for key switch connections are circuit paths on the circuit board are not wires in the harness.

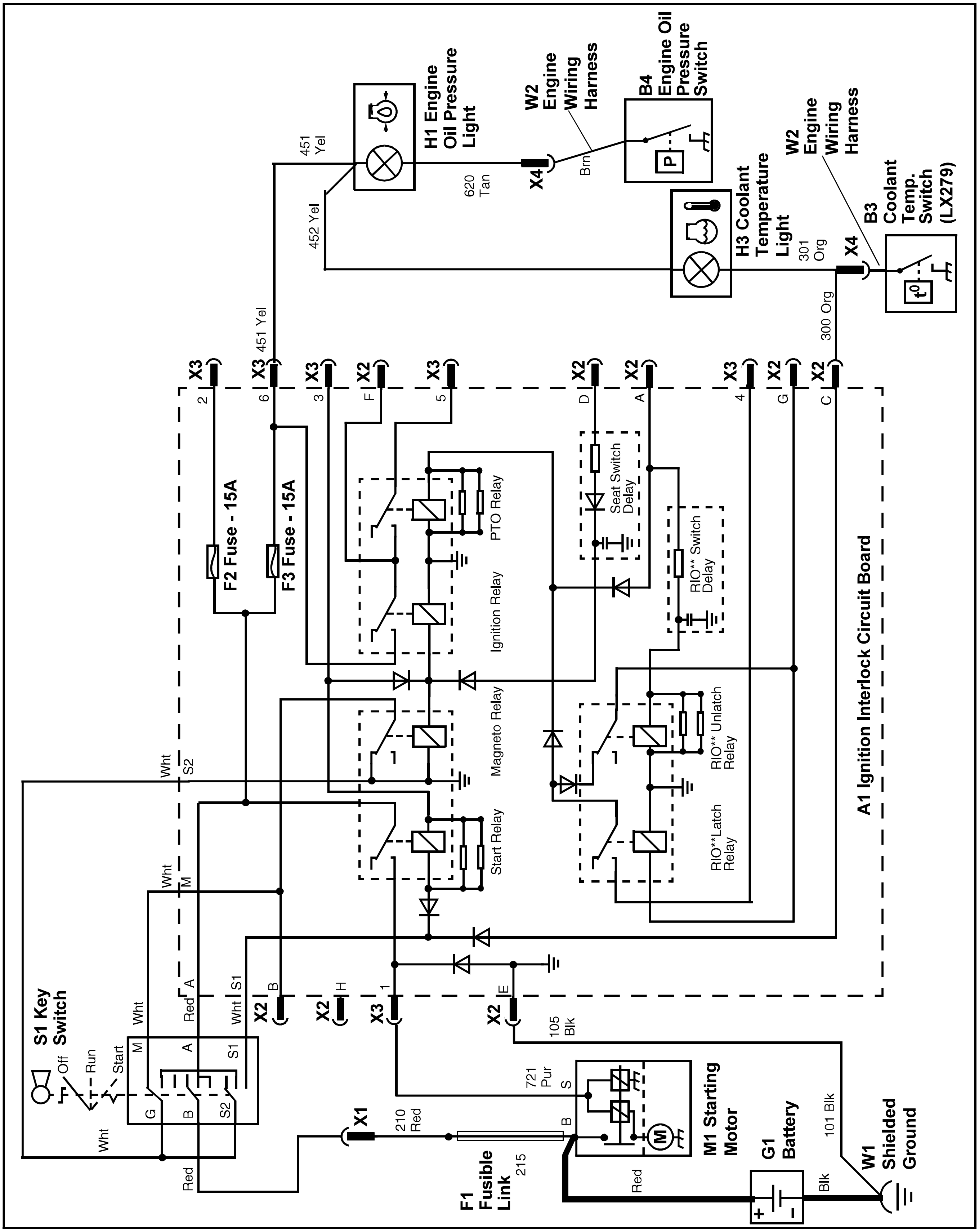
The coolant temperature light system uses a thermal activated switch to provide a path to ground for the coolant temperature light. The switch is closed when engine coolant temperature is at or above 111×C (232×F).

The power circuit provides current to the key switch (S1) and protects the coolant temperature light circuit with a 15 amp fuse (F3). Current flows from the battery (G1) positive (+) terminal to the fusible link (F1) and key switch. With the key switch in the START or RUN position, current flows to the 15 amp fuse (F3), 451 and 452 Yel wires and coolant temperature light.

If the engine coolant temperature exceeds 111×C (232×F) the coolant temperature switch (B3) will close. The coolant temperature switch completes the path to ground and the coolant temperature light comes ON.

When the key switch is in the START position an alternate path to ground is provided through the interlock module (A3) and key switch. This allows the light to be tested during cranking.

Coolant Temperature Light Circuit Schematic - LX279


H1 Engine Oil Pressure Light
W2 Engine Wiring Harness
B4 Engine Oil Pressure Switch
H3 Coolant Temperature Light
B3 Coolant Temp. Switch (LX279)
451 Yel
452 Yel
620 Tan
Brn
301 Org
300 Org
X4
X3
X2
F2 Fuse - 15A
F3 Fuse - 15A
PTO Relay
Ignition Relay
Magneto Relay
Start Relay
Seat Switch Delay
RIO** Switch Delay
RIO** Unlatch Relay
RIO**Latch Relay
A1 Ignition Interlock Circuit Board
S1 Key Switch
Off
Run
Start
Wht
Red
G
B
S2
M
A
S1
105 Blk
721 Pur
S
B
M1 Starting Motor
X1
210 Red
F1 Fusible Link
215
G1 Battery
101 Blk
Blk
W1 Shielded Ground

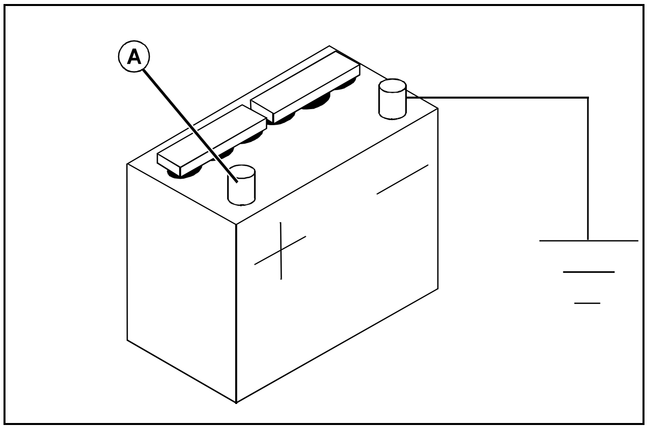
Coolant Temperature Light Circuit Diagnosis

Procedure A

Test Conditions:

- Key switch in RUN position - engine NOT running.

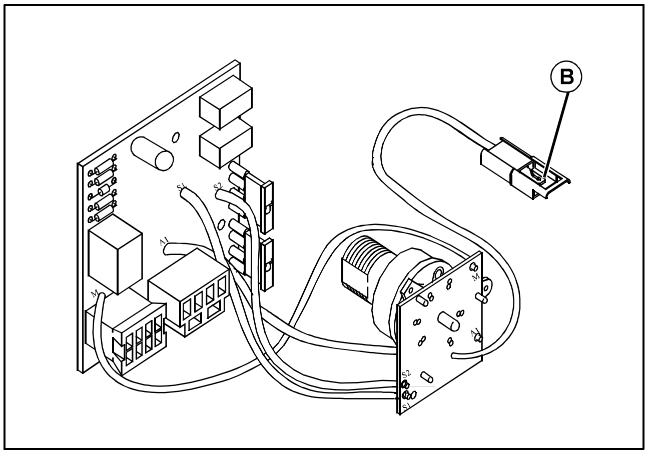
System: Coolant Temperature Light



(1) Is battery voltage present at battery positive (+) terminal (A)?

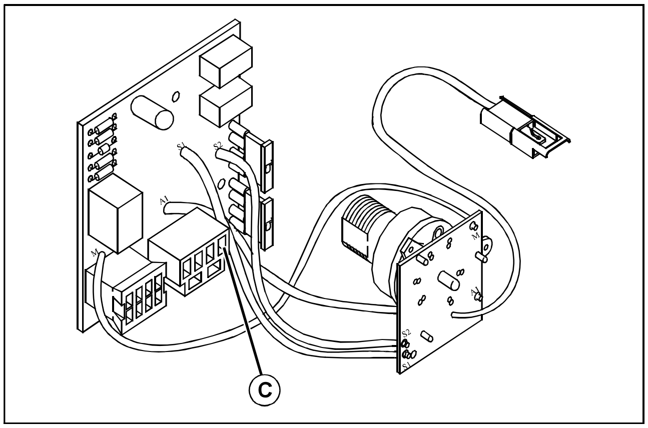
Yes - Go to next step.

No - Test battery.



(2) Is battery voltage present at S1 Key Switch X1 connector (B)?

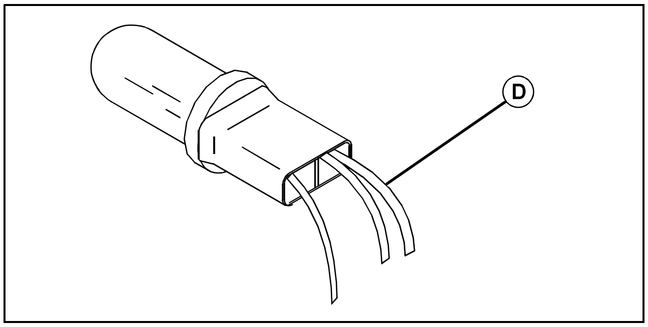
System: Coolant Temperature Light



(3) Is battery voltage present at A1 Interlock Module connector X3, pin 6 (C)?

Yes - Go to next step.

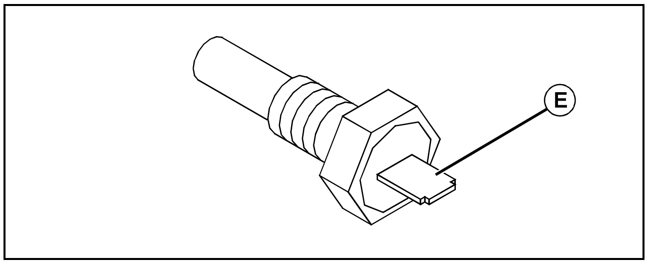
No - Check F3 fuse. If OK, replace interlock module.



(4) Is battery voltage present at 451 and 452 Yel wires at H3 Coolant Temperature Light (light must be OFF)?

Yes - Go to next step.

No - Check 451 and 452 Yel wires and connections.



(5) Is battery voltage present at 301 Org wire of engine coolant temperature switch (E)?

Yes - See “Procedure B” on page 328.

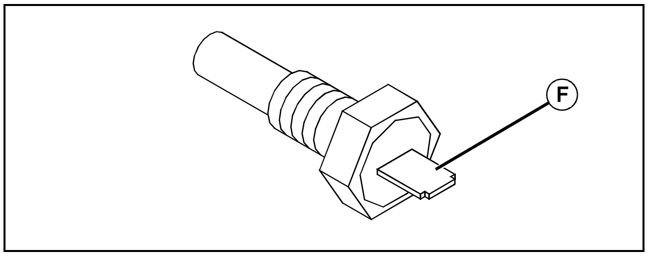
No - Check 301 Org wire, (W2 engine wiring harness), and connections.

Procedure B

Test Conditions:

- Key switch in OFF position.
- Engine at room temperature.

System: Coolant Temperature Light



(1) Is there continuity to ground at engine coolant temperature switch lead?

No - See “Procedure C” on page 328.

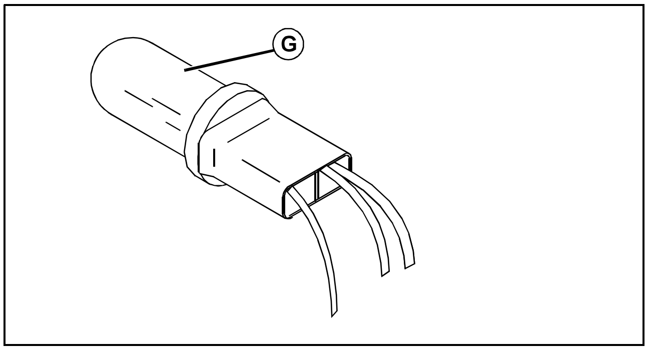
Yes - Replace engine coolant temperature switch.

Procedure C

Test Conditions:

- Key switch in START position.

System: Coolant Temperature Light



(1) Is the engine coolant temperature light (G) ON?

Yes - See “Procedure D” on page 328.

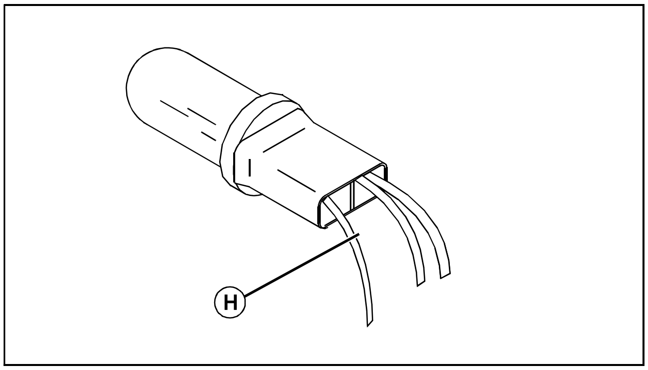
No - Check ground circuit. If OK, replace light bulb.

Procedure D

Test Conditions:

- Battery positive (+) cable disconnected.
- Key switch in START position.

System: Coolant Temperature Light



(1) Is the resistance measured at 300 Org/Wht wire 0.1 ohms or less?

No - Check 300 Org/Wht wire (H), Wht wire (S1) at key switch, Wht wire (S2) at interlock module, 105 and 101 Blk wires, battery negative (-) cable and shielded ground and connections. If OK, replace interlock module.

Tests and Adjustments

Common Circuit Tests

Shorted/Grounded Circuit:

A shorted circuit on the ground side of a component (i.e. improper wire-to-wire or wire to ground contact) may result in improper component operation.

A shorted circuit on the power side of a component or contact of two power circuits (i.e. improper wire-to-wire or wire to ground contact) may result in blown fusible link and fuses.

To test for a shorted or improperly wired circuit:

1. Turn component ON.
2. Start at the controlling switch of the component that should not be operating.
3. Follow the circuit and disconnect wires at connectors until components stop operating.
4. Shorted or improper connections will be the last two wires disconnected.

High Resistance or Open Circuit:

High resistance or open circuits usually result in slow, dim, or no component operation (i.e. poor, corroded, or severed connections). Voltage at the component will be low when the component is in operation. To test for high resistance and open circuits:

1. Check all terminals and ground connections of the circuit for corrosion.
2. If the terminals are not loose or corroded, the problem is in the component wiring.

Ground Circuit Test

Reason:

To check for open circuits, loose terminal wire crimps, poor connections, or corrosion in the ground circuit.

Equipment:

- Ohmmeter or Voltmeter

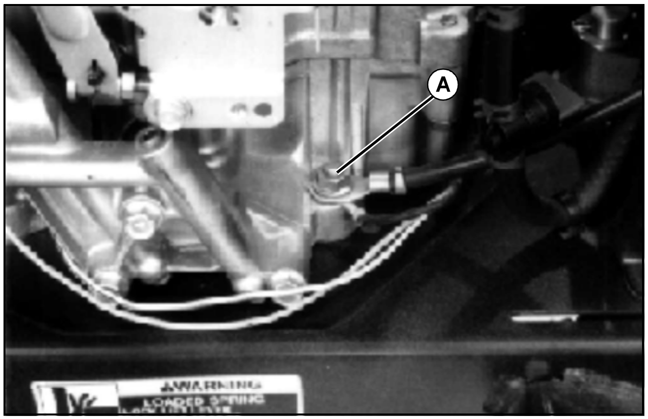
NOTE: The voltmeter method checks ground connections are under load.

Procedure - Ohmmeter Method:

1. Park machine on a level surface.
2. Turn key switch OFF.
3. Move forward reverse pedals to NEUTRAL position.
4. Lock parking brake.
5. Raise hood.
6. Connect ohmmeter negative (black) lead to negative terminal of battery. Connect ohmmeter positive (red) lead to negative terminal of battery and record reading.
7. Connect ohmmeter red lead to ground terminal (A) of circuit or component to be tested that is closest to the battery negative terminal. Resistance reading must be the same or very close to the battery negative terminal reading. Work backward from the battery on the ground side of the problem circuit until the resistance reading is above 0.1 ohms. If the reading is above 0.1 ohms, the problem is between the last two test points. If a problem is indicated, disconnect the wiring harness connector to isolate the wire component and check resistance again. Maximum allowable resistance in the circuit is 0.1 ohms. Check both sides of the connection closely, as disconnecting and connecting may temporarily solve the problem.

Procedure - Voltmeter Method:

1. Park machine on a level surface.
2. Move forward/reverse pedals to NEUTRAL position.
3. Lock parking brake.
4. Turn key switch to ON position.
5. Raise hood.
6. Connect voltmeter negative (black) lead to negative terminal of battery.



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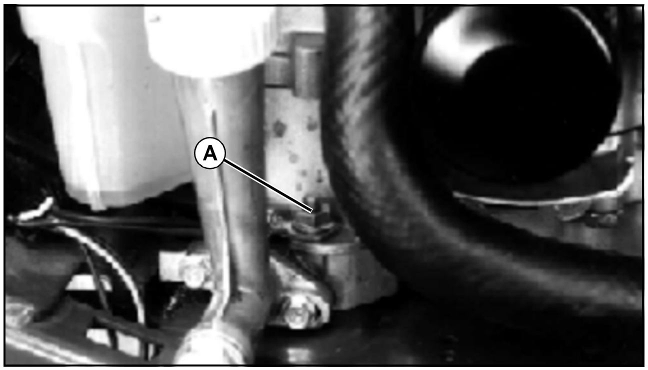

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7. Connect voltmeter positive (Red) lead to ground terminal (A) of circuit component to be tested. Be sure that the component circuit is activated (key ON, switch(es) Closed) so that voltage will be present at the component. Record voltage. Voltage must be greater than 0, but less than 1 volt. Some components will have a very small voltage reading on the ground side and still be operating correctly.

Results:

- If voltage is 0, the component is open.
- If voltage is greater than 1 volt, the ground circuit is bad. Check for open wiring, loose terminal wire crimps, poor connections, or corrosion in the ground circuit.

Battery Voltage and Specific Gravity Test

Reason:

To check voltage and determine condition of battery.

Equipment:

- Voltmeter or JT05685 Battery Tester.
- Hydrometer Procedure.
- Clean battery terminals and top of battery.

Procedure:

CAUTION: Avoid injury! Sulfuric acid in battery electrolyte is poisonous. It is strong enough to burn skin, eat holes in clothing, and cause blindness if splashed into the eyes.

Avoid the hazard by:
Filling batteries in a well-ventilated area,
Wearing eye protection and rubber gloves,
Avoiding breathing fumes when electrolyte is added.
Avoid spilling or dripping electrolyte.
Use proper jump-start procedure.

If you spill acid on yourself:
Flush your skin with water.
Apply baking soda or lime to help neutralize the acid.
Flush your eyes with water for 10 - 15 minutes.
Get medical attention immediately.

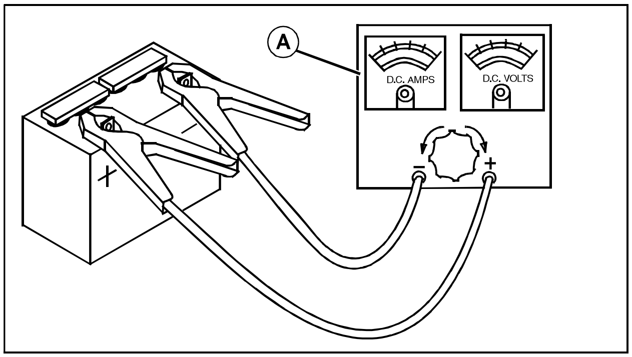
If acid is swallowed:
Drink large amounts of water or milk.
Then drink milk of magnesia, beaten eggs, or vegetable oil.
Get medical attention immediately.

1. Park machine safely with park brake locked.

2. Inspect battery terminals and case for breakage or cracks.

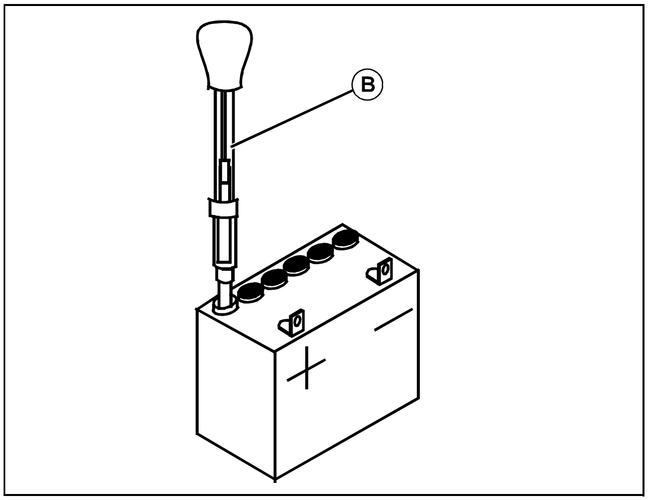
3. Check electrolyte level in each battery cell. Add clean, soft water as needed. If water added, charge battery for 20 minutes at 10 amps.

4. Remove surface charge by placing a small load on the battery for 15 seconds.



MIF

5. Check battery voltage with voltmeter or JT05685 battery tester. (A).



MIF

6. Use an hydrometer (B) to check for a minimum specific gravity of **1.265** with less than **50** point variation in each cell at full charge at **26.7°C (80°F)**.

Results:

- Battery voltage less than **12.4 VDC**, charge battery.
- Battery voltage more than **12.4 VDC**, test specific gravity.
- All cells less than **1.175**, charge battery at 10 amp rate.
- All cells less than **1.225** with less than 50 point variation, charge battery at 10 amp rate.
- All cells more than **1.225** with less than 50 point variation, load test battery.

- More than **50** point variation: replace battery.

Specifications:

Minimum battery voltage .... 12.4 volts
Minimum specific gravity
.... 1.225 with less than 50 point variation

Battery - Charge

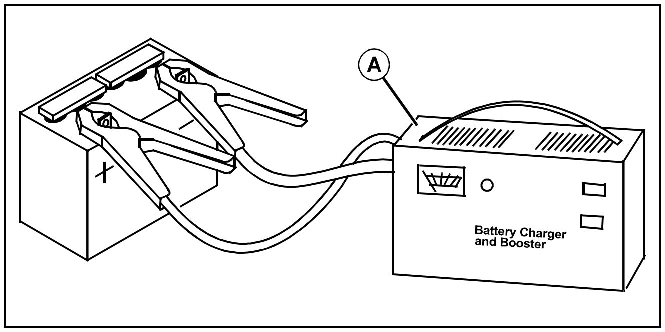
Reason:

To increase battery charge after battery has been discharged.

Equipment:

- Battery charger (variable rate)

Procedure:



MIF

1. Connect variable rate charger to battery (A).

NOTE: Maximum charge time at boost setting is 10 minutes. Allow an additional 5 minutes for each 10 degrees below 70 degrees F.

2. Start charger at slow rate. Increase charge rate one setting at a time. Check charger ammeter after 1 minute at each setting. Maintain 10 amp charge rate. Use boost setting as necessary.

3. Check if battery is accepting a 10 amp charge after 10 minutes at boost setting.

   - Battery will not accept 10 amp charge after 10 minutes at boost setting: replace battery.
   - Battery is accepting 10 amp charge after 10 minutes at boost setting, and battery did not need water: go to steps 6 and 7.
   - Battery is accepting 10 amp charge after 10 minutes at boost setting, but battery did need water or all cells were below 1.175: go to steps 4 and 5.

IMPORTANT: Avoid damage! Decrease charge rate if battery gases or bubbles excessively or becomes too warm to touch.

4. Set charger at 15 - 25 amps.

5. Check specific gravity after 30 minutes (60 minutes for maintenance-free battery).

NOTE: If battery was discharged at slow or unknown rate, charge at 10 - 15 amps for 6 - 12 hours (Maintenance-free battery: 12 - 24 hours). If battery was discharged at fast rate, charge at 20 - 25 amps for 2 - 4 hours (Maintenance-free battery: 4 - 8 hours).

   - More than 50 point variation between cells: replace battery.
   - Less than 50 point variation between cells: go to steps 6 and 7.

6. Continue charging battery until specific gravity is **1.230 - 1.265 points**.

7. Load test battery.

Battery - Load Test

Reason:

To check condition of battery under load.

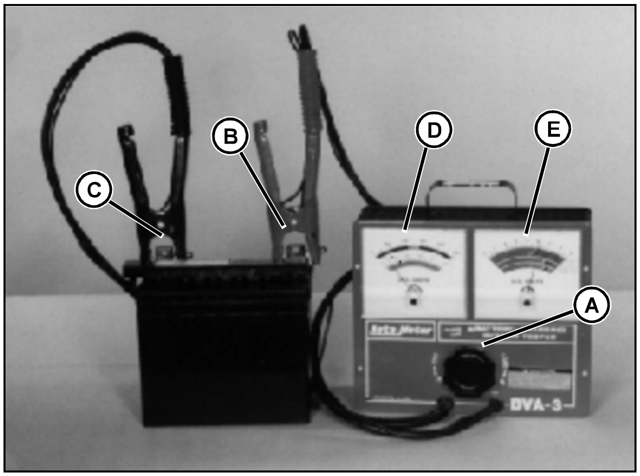
NOTE: Charge battery before performing load test.

Equipment:

- JT05685 Battery Tester

NOTE: Use the procedures given with the tester.

Connections:



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1. Turn load knob (A) of tester counter-clockwise to off.

2. Connect tester positive cable (B) to battery positive terminal.

3. Connect tester negative cable (C) to battery negative terminal.

Procedure:

1. Turn load knob of tester clockwise until amperage reading is equal to:
   - Cold cranking amperage rating (blue scale).

   or

   - Three times ampere hour rating (black scale).
2. Hold for 15 seconds and turn load knob of tester off.
3. Read battery voltage.

Results:

- If the battery does not indicate 9.6 volts or more, replace battery.

Regulated Amperage Test

Reason:

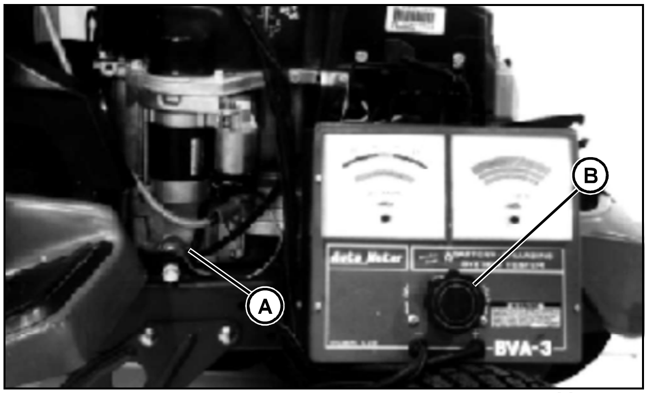
To determine charging output of rectifier/regulator.

Test Equipment:

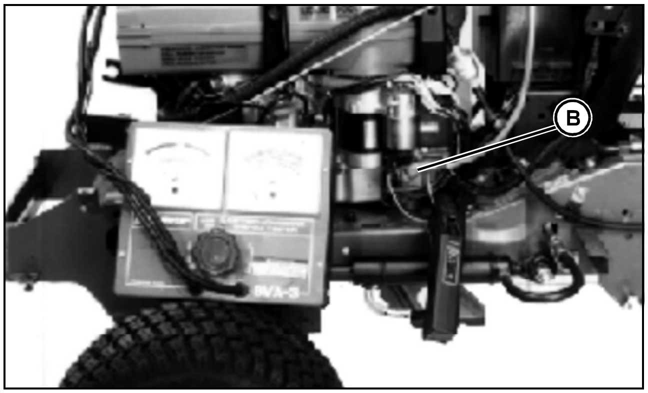
- JT05712 Current Gun
- JT05685 Battery tester

Procedure:

1. Park machine on a level surface.
2. Turn key switch OFF.
3. Move forward/reverse pedals to neutral position.
4. Lock parking brake.
5. Raise hood.

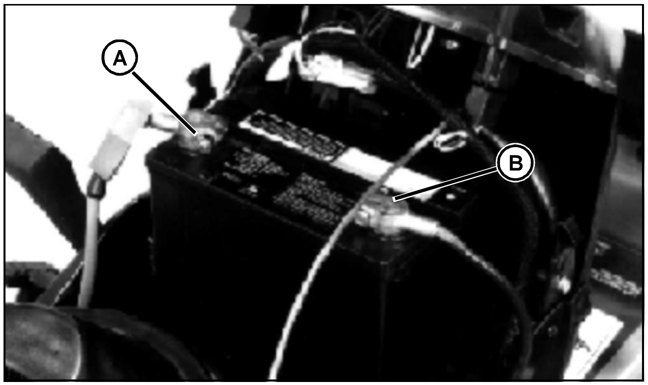


Picture Note: LX277



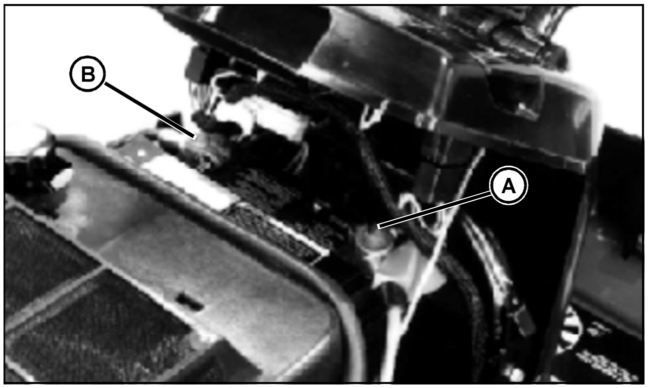
Picture Note: LX279

6. Put JT05712 Current Gun over small wire (A).
7. Set Current Gun for DC current.



Picture Note: LX277

8. Turn load knob (B) to maximum counterclockwise position.



Picture Note: LX279

9. Connect JT05685 Battery Tester to battery:

Connect tester positive (Red) cable to battery positive (+) terminal.

Connect tester negative (black) cable to battery negative (-) terminal.

IMPORTANT: Avoid damage! Perform this test quickly to prevent damage to the battery tester. DO NOT apply full load to battery for more than 5 - 10 seconds.

10. Start engine and run at fast idle.

11.Turn load knob clockwise until voltage read on tester voltage scale is 11 volts. Also read amperage. Amperage should read a minimum of 13 amps.

Results:

- If reading does not meat specifications, test unregulated voltage output. See “Unregulated Voltage Output Test” on page 333.
- If unregulated voltage meets specifications and voltage and ground to the regulator/rectifier is verified, replace the regulator/rectifier.

Regulated Voltage Test

Reason:

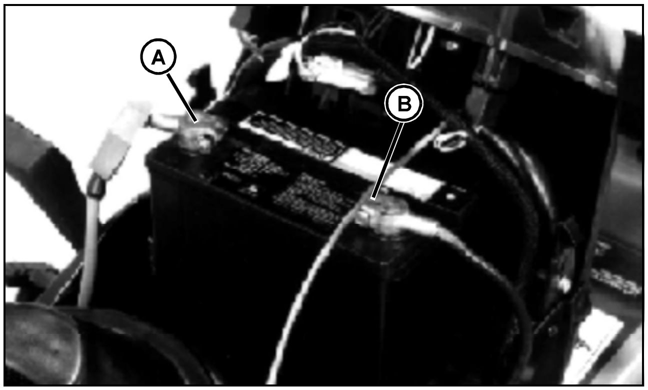
To determine regulated voltage output of the regulator/ rectifier.

Test Equipment:

- Voltmeter

Procedure:

1. Park machine on a level surface.
2. Turn key switch OFF.
3. Lock parking brake.
4. Raise hood.
5. Remove surface charge from battery by placing a small load on the battery for 15 seconds.
6. Set voltmeter for 25 of 50 volt DC scale



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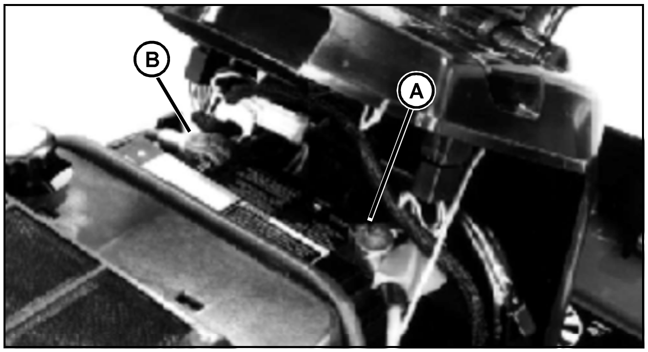

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7. Connect voltmeter positive (Red) lead to battery positive (+) terminal (A).
8. Connect voltmeter negative (black) lead to battery negative (-) terminal (B).
9. Read voltmeter several times during 5 minutes of running time. Voltage should remain between 12.2 - 14.7 volts DC.

Results:

- If the DC voltage remains below the minimum specification, test unregulated voltage output. See “Unregulated Voltage Output Test” on page 333.
- If the DC voltage goes above the maximum specification, replace the regulator/rectifier.

Unregulated Voltage Output Test

Reason:

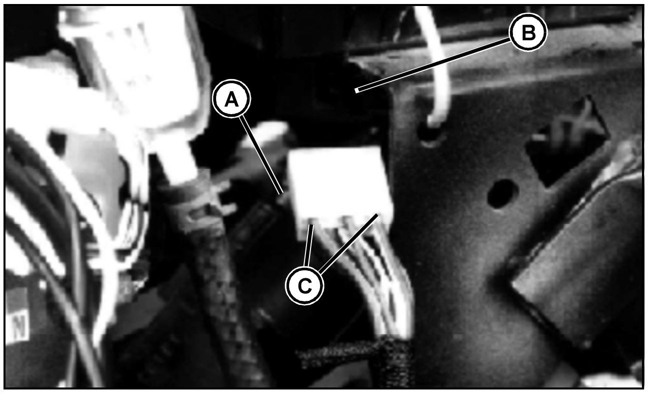
To measure stator voltage output to determine stator condition.

Test Equipment:

- Voltmeter

Procedure:

1. Park the machine on a level surface.
2. Turn the key switch OFF.
3. Move the forward/reverse pedals to NEUTRAL position.
4. Lock parking brake.
5. Raise hood.



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6. Disconnect connector (A) from voltage regulator/rectifier (B).

7. Set voltmeter to 50 volt AC scale.

8. Connect voltmeter leads to connector wire (C).

9. Start and run engine at fast idle.

10. Measure stator output voltage. Voltage should read a minimum of 26 volts AC.

Results:

- If voltage is less than specifications, test flywheel magnet and then replace stator. See “Flywheel Magnet Test” on page 335.

Regulator/Rectifier Test

Reason:

To determine if voltage regulator/rectifier is defective.

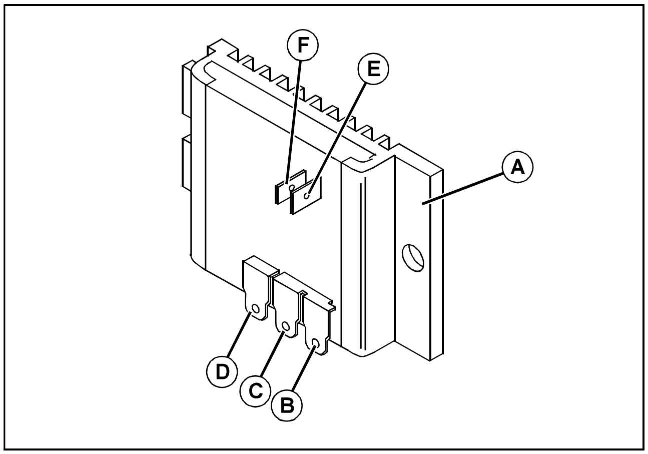
Equipment:

- Voltmeter

Procedure:

1. Park machine safely.

2. Disconnect wiring harness from voltage regulator/ rectifier.



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3. Measure resistance between each indicated point. Compare readings to table.

Results:

- +	A	B	C	D	E	F
A		infinite	infinite	infinite	19 ~ 3 K ohms	3 K ohms ~ infinite
B	infinite		0	500 ohms ~ infinite	infinite	infinite
C	infinite	0		500 ohms ~ infinite	infinite	infinite
D	7.5 K ohms ~ infinite	925 ohms ~ infinite	925 ohms ~ infinite		10 K ohms ~ infinite	10 K ohms ~ infinite
E	330 ohms ~ infinite	infinite	infinite	infinite		1.2 K ohms ~ infinite
F	14 K ohms ~ infinite	infinite	infinite	infinite	110 ohms ~ infinite	

If resistance measurements do not match any table listing, replace voltage regulator/rectifier.

Flywheel Magnet Test

Reason:

To make sure the flywheel magnet has enough force to induce current in the ignition coil.

Procedure:

1. Park machine on a level surface.
2. Turn key switch OFF.
3. Move forward/reverse pedals to the NEUTRAL position.
4. Lock parking brake.
5. Remove:
   - Blower housing.
   - Cooling air duct (LX279).
6. Hold steel tool about 25 mm (1.0 in.) from flywheel magnet. The tool should be attracted to the magnet.

Results:

Replace the flywheel if the magnet does not attract tool.

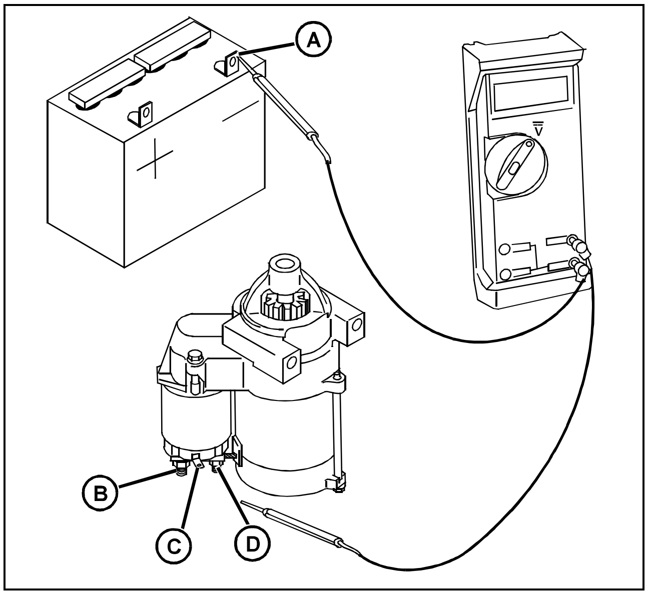
Starting Motor Solenoid Test

Reason:

To determine if starting motor solenoid is defective.

Procedure:

1. Park machine on a level surface.
2. Turn key switch to the OFF position.
3. Move forward/reverse pedals to NEUTRAL position.
4. Lock park brake.
5. Place PTO/RIO switch in OFF position.
6. Raise hood.
7. Disconnect and ground spark plug lead.



MIF

8. Connect VOM to negative (-) battery cable (A) and other lead to terminal (B) of starting motor.
9. Battery voltage - go to next step.
10. Check red cable and connections from battery and starter solenoid terminal (B) for loose connections. Clean any corrosion.
11. Connect VOM to negative (-) battery terminal (A) and terminal (C) of starting motor.
12. Momentarily turn ignition key to START position and check for battery voltage.
13. No battery voltage - Check cranking circuit. See “Cranking Circuit Diagnosis” on page 279.

Results:

- No battery voltage. Starter solenoid is defective.
- Battery voltage - Starting motor is possibly defective. See “Starting Motor” on page 350.

Starter Loaded Amperage Draw Test

Reason:

To determine the amperage required to crank the engine and check the starter motor operation under load.

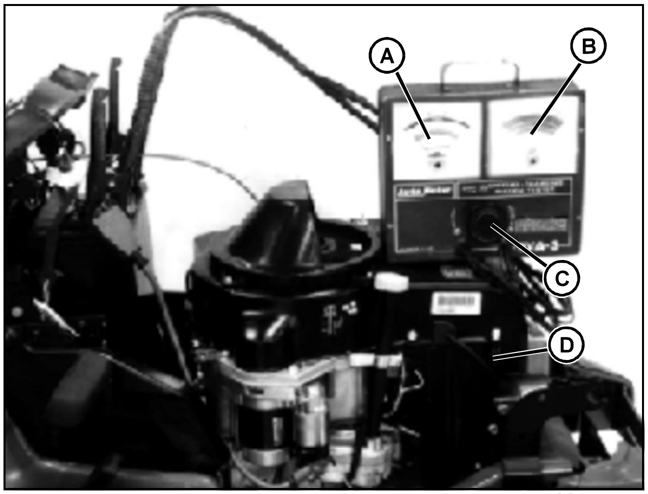
Test Equipment:

- JT05685 Battery Tester
- JT07270 Hand Held Digital Tachometer

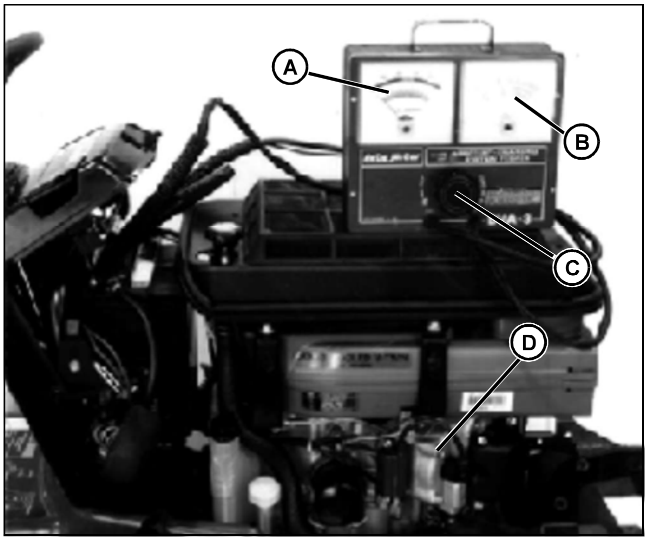
Procedure:

1. Test system ground connections. See “Ground Circuit Test” on page 329.

2. Test battery. See “Battery - Load Test” on page 331.



M83234



M83231

3. Turn knob (C) of battery tester to maximum counterclockwise OFF position.

4. Connect positive (red) clamp of battery tester to positive (+) terminal of battery and negative (black) clamp to negative (-) terminal of battery.

5. Remove spark plug high tension leads (D) and ground to engine.

6. Crank engine and read voltage on DC voltage scale (B) of Battery Tester. Check engine rpm using JT07270 Hand Held Digital Tachometer. (Not used on LX279.)

7. Turn key switch to OFF position.

IMPORTANT: Avoid damage! Perform the following procedure within 15 seconds to prevent electrical damage to components.

8. Turn knob on battery tester clockwise until the DC voltage is the same as when cranking.

9. Read DC amperage (A) on Battery Tester. Maximum starter amperage draw should be 85 amps at 500 rpm (rpm not measured on LX279).

Results:

If amperage is above specification, or cranking rpm is low, test starter no load rpm and amperage. See “Starting Motor No-Load Amperage & RPM Tests” on page 336.

Starting Motor No-Load Amperage & RPM Tests

Reason:

To determine starting motor condition under no-load conditions.

Required Tools:

- JT05791 Multitester
- JT02153 Current Clamp
- 12 Volt Battery
- JT07270 Hand Held Digital Tachometer
- Jumper Cables
- Jumper Wire (Do connect the starting motor positive post and the solenoid shift connector.)

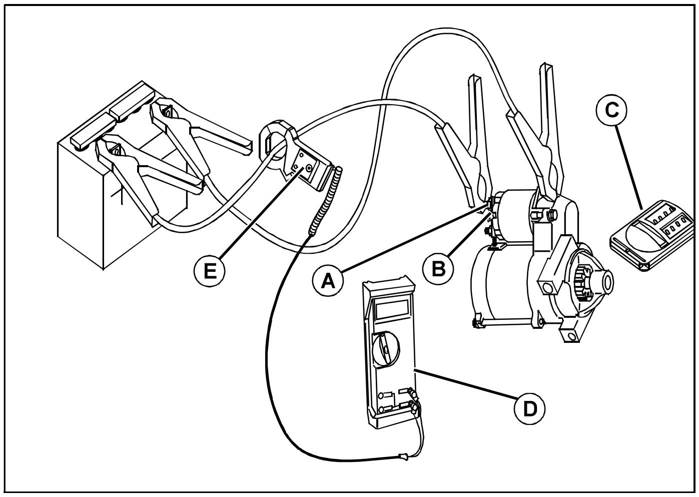
Procedure:

IMPORTANT: Avoid damage! Do not strike starting motor housing with a hammer. Clamp only on the mounting bracket. starting motors contain two ceramic magnets that can be broken or cracked if the motor housing is hit, deformed, or dented.

1. Park machine on a level surface.
2. Turn key switch to OFF position.
3. Move forward/reverse pedals to NEUTRAL position.
4. Lock park brake.
5. Raise hood.
6. Remove starting motor.

IMPORTANT: Avoid damage! When connecting wires and meter, ensure connections are not touching any surface where a ground short may occur. Wrap connections with electrical tape if necessary.

7. Clamp the starting motor mounting bracket in a vise.
8. Connect negative jumper cable to battery negative (-) post and the frame of the starting motor.
9. Connect positive jumper cable to the positive (+) post of the battery.



MIF

10.Connect JT02153 current clamp (E) red lead to the VOLTS jack of the JT05712 multi tester (D) and the black lead of the current clamp to the COM jack on the multi tester.

11.Clamp jaws of current clamp around the positive jumper cable.

IMPORTANT: Avoid damage! Adjust the DCA ZERO ADJUST dial or the current clamp for a zero reading on the multitester.

NOTE: The core of the jaws may hold some magnetic force after the current clamp has been used for measurement. If you cannot adjust the display to zero, open the jaws and snap them closed several times.

12.Set the current clamp to 2000A and the multitester to 300mV.

IMPORTANT: Avoid damage! Connect the positive jumper cable lead to the starting motor positive post (A).

13.Momentarily connect the starting motor positive post (A) to the starting motor solenoid shift connector (B), and read the starting motor amperage draw.

14.Disconnect and remove the current clamp.

15.Place a piece of reflective tape on the starting motor gear shaft.

16.Momentarily touch positive jumper cable lead to the starting motor positive post and read the starting motor rpm.

Results:

- A good starting motor should have a maximum amperage reading of 50 amps and a minimum rotational reading of 6000 rpm by using the JT07270 Hand Held Digital Tachometer (C).
- If amperage reading is above 50 amps or starting motor rpm is less than 6000, check for binding or seized bearings, sticky brushes, and dirty or worm commutator. Repair or replace starting motor.

Spark Test - LX255, LX266 & LX288 (SN - 090000)

Reason:

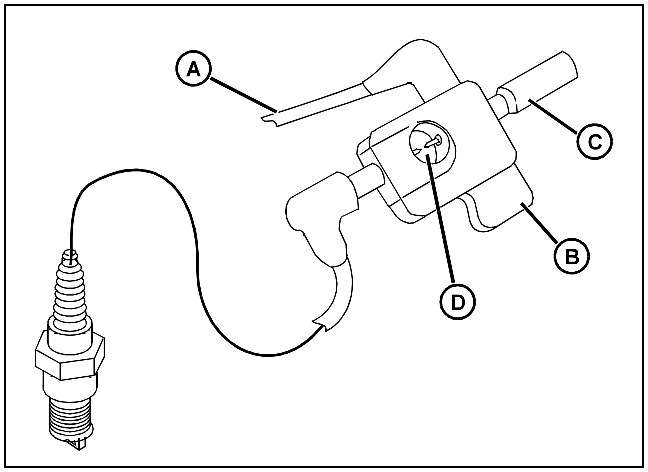
To check overall condition of ignition system.

Equipment:

- D-05351ST Spark Tester

Procedure:

1. Park machine on a level surface.
2. Turn key switch to OFF position.
3. Move forward/reverse pedals to NEUTRAL position.
4. Wheels blocked and park brake OFF.
5. Raise hood.



MIF

6. Remove high tension lead (A) from spark plug and connect spark tester (B).
7. Connect spark tester lead to spark plug.

IMPORTANT: Avoid damage! Do not adjust spark tester gap beyond 5.0 mm (0.200 in.) as damage to ignition system components could occur.

8. Adjust spark tester gap to 4.2 mm (0.166 in.) with screw (C).
9. Turn key switch to RUN position and start engine.

10.Watch spark (D)) at spark tester.

Results:

- If engine will start, watch spark with engine running.

There should be a strong, steady, blue spark.

- If spark is weak, or no spark, install a new spark plug and test again.
- If spark is still weak, or still no spark, check armature air gap and adjust as needed.
- If spark is still weak, or still no spark, replace ignition armature.

Ignition Coil Test - LX277 & LX288 (SN 090001 -)

Reason:

Check windings of ignition coil.

Test Equipment:

- Ohmmeter

Procedure:

This test procedure requires removal of the blower housing.

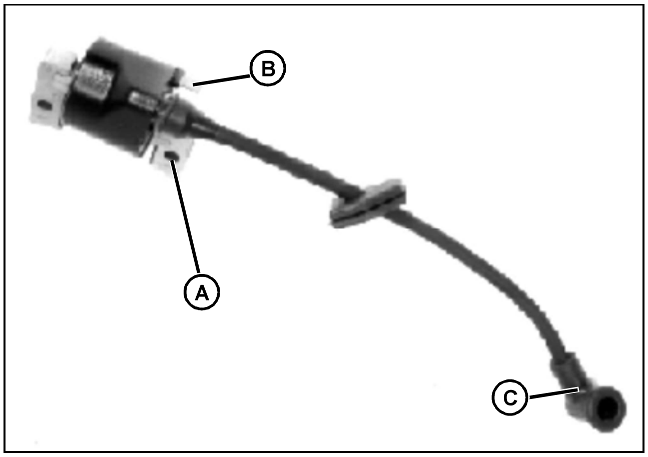
	A	B	C
A		OL	9.0 k
B	1.9 m		1.9 m
C	9.0 k	OL	

1. Measure the resistance between each point as shown in the chart If resistance is not within specification, replace armature with coil.

Armature Air Gap Adjustment

1. Center flywheel magnet under armature.

2. Insert a feeler gauge between flywheel and armature. See specifications below.



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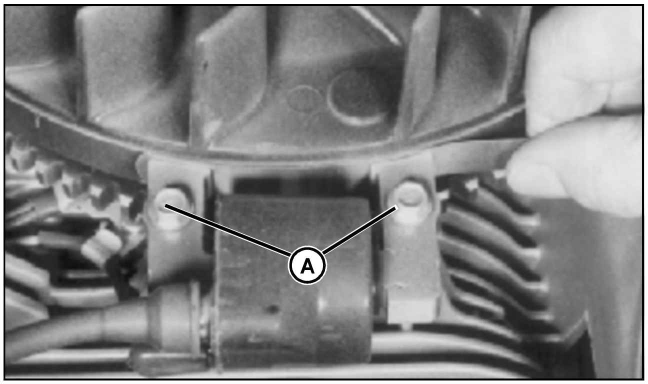


M45869

3. Push armature against flywheel and tighten screws (A) to 7.8 N•m (69 lb-in.).

4. Turn flywheel to remove feeler gauge.

Specifications:

LX255 Gap. . . . . 0.25 mm (0.01 in.)
LX266 Gap . . . . .0.25 mm (0.01 in.)
LX277 Gap . . . . 0.25 - 0.40 mm (0.010 - 0.016 in.)
LX279. . . . . Fixed position, no adjustment
LX288
(SN - 090000) Gap . . . . 0.20 - 0.30 mm (0.008 - 0.12) in.)
LX288 (SN 090001 -) Gap . . . . .0.030 mm (0.012 in.)
Armature Screws . . . . .7.8 N•m (69 lb-in.)

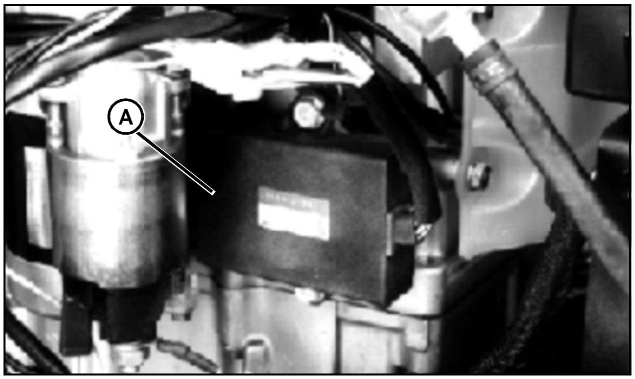
Ignition Module Test - LX279

Reason:

To determine if the ignition module is defective.

Procedure:

1. Park machine on a level surface.
2. Move forward/reverse pedals to NEUTRAL position.
3. Lock parking brake.
4. Turn key switch OFF.
5. Raise hood.



M83232

6. The ignition module (A) is very sensitive to the type of ohmmeter used to check resistance. Due to variations in ohmmeters, the best way to determine if the ignition module is good is to replace the questionable ignition module with a known good module.

Results:

- If the new ignition module does not solve the problem, check other ignition components.

Ignition Coil Test - LX279

Reason:

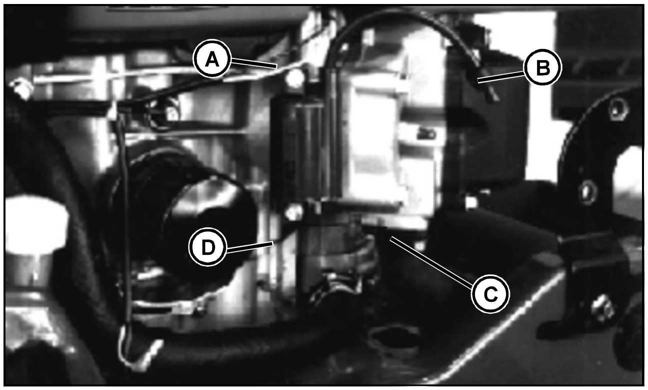
Check primary and secondary windings of ignition coil.

Test Equipment:

- Ohmmeter

Procedure:

1. Park machine on a level surface.
2. Move forward/reverse pedals to NEUTRAL position.
3. Lock parking brake.
4. Turn key switch OFF.
5. Raise hood.
6. Disconnect wires from ignition coil terminals.



M83233

7. Unscrew spark plug cap from high tension lead (B).
8. Set ohmmeter to 1x ohms scale.

Primary Windings:

NOTE: Resistance may vary between ohmmeters.

9. Connect one ohmmeter lead to coil positive (+) (wide) terminal (D).
10. Connect other ohmmeter lead to coil negative (-) terminal (C).
11. Measure resistance across primary windings.

Resistance should measure 3.4 - 4.6 ohms.

Secondary Windings:

12. Set ohmmeter to 10kx (10,000) ohms scale.
13. Connect one ohmmeter lead to coil positive (+) terminal (D).

NOTE: Test spark plug cap resistance before installing on high tension lead. See "Spark Plug Cap Test - LX279" on page 340.

14. Connect other ohmmeter lead to high tension lead (B).
15. Measure resistance across secondary winding.

Resistance should measure 10,400 - 15,000 ohms.

Open Circuit Check:

16. Connect one ohmmeter lead to coil positive (+) terminal (D) or coil negative (-) terminal (C).

NOTE: Do not connect ohmmeter lead to ignition coil mounting screws as this will result in an inaccurate reading.

17. Connect other ohmmeter lead to coil core (A).
18. Measure resistance from primary leads to coil core. There should be no continuity (open circuit) between coil primary terminals and coil core.
19. Connect one ohmmeter lead to high tension lead (B).

NOTE: Do not connect ohmmeter lead to ignition coil

mounting screws as this will result in an inaccurate reading.

20.Connect other ohmmeter lead to coil core (A).

21.Measure resistance from high tension lead to coil core. There should be no continuity (open circuit) between high tension lead and coil core.

22.Repeat test procedures on other ignition coil.

Results:

- If the ohmmeter readings are not within specifications, replace coil(s).
- If ohmmeter readings are within specifications, the coils are probably good. If system still does not perform properly after all tests/checks, replace coil with a good coil.

Pulser Coil Test - LX279

Reason:

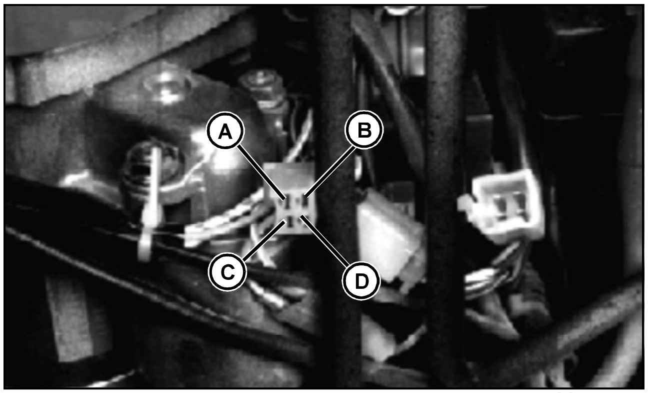
To check if the pulser coil is operating properly

Test Equipment:

- Ohmmeter

Procedure:

1. Park machine on a level surface.
2. Move forward/reverse pedals to NEUTRAL position.
3. Lock parking brake.
4. Turn key switch OFF.
5. Raise hood.
6. Set ohmmeter to 1x ohms scale.
7. Disconnect pulser connector.



M49898

8. Connect one meter lead to the blue/white wire (A). Connect other meter lead to pink wire (D).
9. Measure resistance. Resistance should measure 88 - 132 ohms.
10. Connect one meter lead to green/white wire (B). Connect other meter lead to yellow wire (C).
11. Measure resistance. Resistance should measure 88 - 132 ohms.

Results:

NOTE: resistance values may vary between ohmmeters.

- If either pulser coil is out of specification, replace pulser coil/harness assembly.

Spark Plug Cap Test - LX279

Reason:

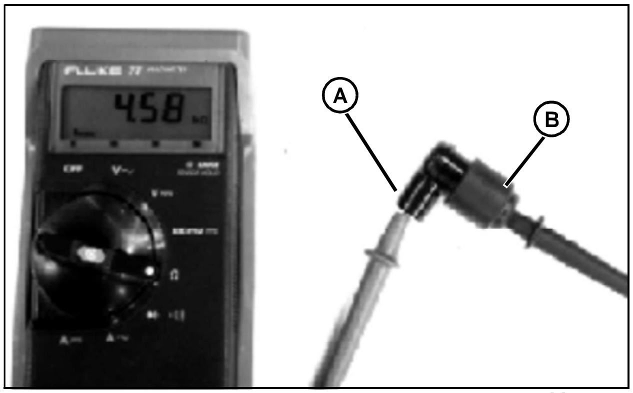
To determine the resistance of the spark plug cap.

Test Equipment:

Ohmmeter

Procedure:

1. Park machine on a level surface.
2. Move forward/reverse pedals to NEUTRAL position.
3. Lock parking brake.
4. Turn key switch OFF.
5. Raise hood.
6. Unscrew spark plug cap from high tension lead.



M49697

7. Connect one meter lead to spark plug side (B) of spark plug cap.
8. Connect other meter lead to high tension side (A) of spark plug cap.
9. Measure resistance. Resistance should be within 10% of value marked on cap.

Results:

- If resistance is not within specifications, replace cap.

Light Switch Test

Reason:

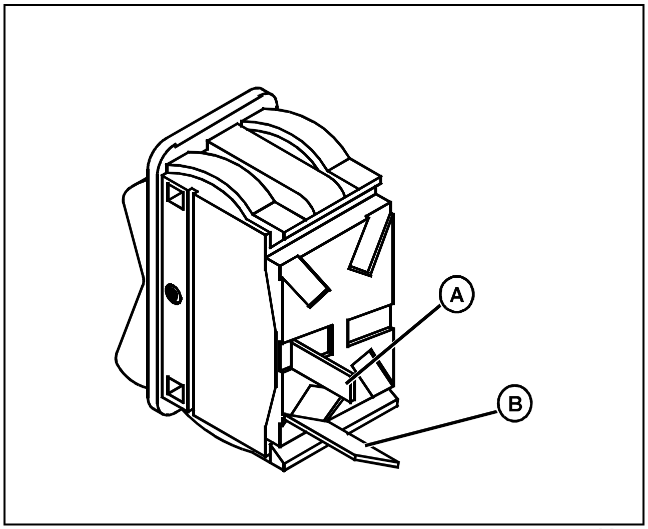
To make sure the light switch terminals have continuity when the light switch is ON.

Equipment:

- Ohmmeter or Continuity Tester

Procedure:

1. Park machine on a level surface.
2. Move forward/reverse pedals to NEUTRAL position.
3. Lock parking brake.
4. Turn key switch OFF.
5. Raise hood.
6. Disconnect light switch connector.



MIF

7. Move light switch to the ON and the to the OFF position. Check continuity between terminals (A and B).

Results:

- Terminals should have continuity with switch ON.
- Terminals should NOT have continuity with switch OFF.
- If continuity is NOT correct, replace light switch.

PTO/RIP Switch Test

Reason:

To verify PTO/RIP switch functions are operating properly.

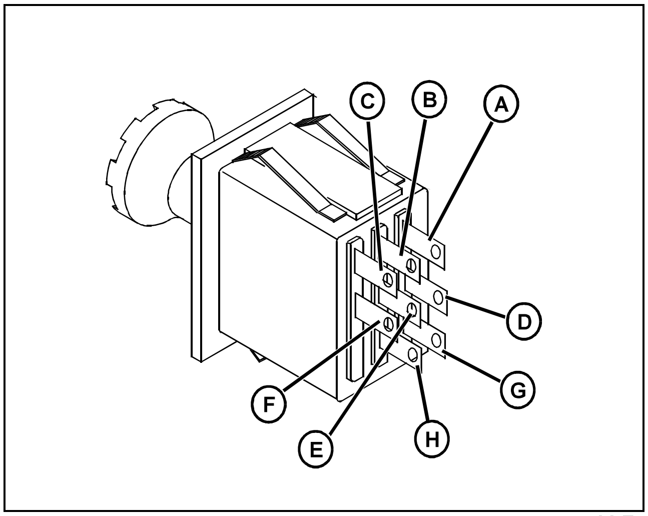
Equipment:

- Ohmmeter or Continuity Tester

Procedure:

1. Park machine on a level surface.
2. Move forward/reverse pedals to NEUTRAL position.
3. Lock parking brake.
4. Turn key switch OFF.
5. Disconnect PTO/RIP switch connector.
6. Use an ohmmeter to test continuity in OFF and ON positions.

PTO/RIP Switch Continuity:



MIF

Switch Position Terminal Continuity:

OFF	**A and C**
	D and F
ON	**A and B**
	D and E
Momentary ON	**A and B**
	D and E
	G and H

Results:

- All other possible combinations have infinite resistance. If an continuity is not correct, replace switch.

Seat Switch Test

Reason:

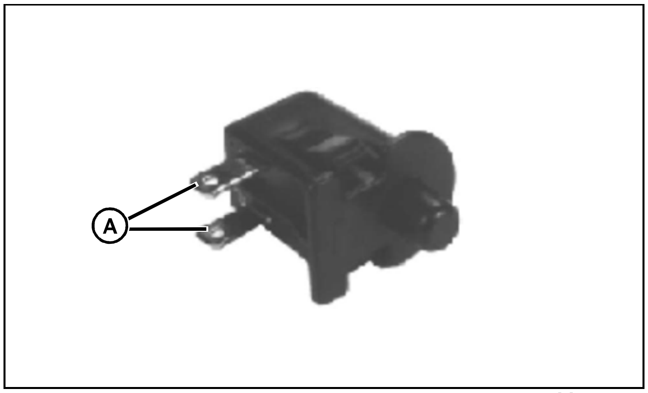
To verify proper operation of seat switch.

Equipment:

- Ohmmeter or Continuity Tester

Procedure:

1. Park machine safely in neutral with park brake locked.
2. Turn key to OFF position.
3. Disconnect seat switch connector.
4. Depress the seat switch plunger.



M48379

5. Check continuity across seat switch connector terminals (A). There should be continuity.
6. Release the seat switch plunger.
7. Check continuity across connector terminals. There should not be continuity.

Specifications:

Seat switch plunger depressed. . . . . .Continuity
Seat switch plunger released . . . . No continuity

Results:

- If the seat switch does not have continuity with the operator on the seat, check the seat switch bracket and spring for damage.
- If the seat switch does not have continuity with the plunger depressed, replace the switch.

RIO Switch Test

Reason:

To determine proper operation of RIO switch.

Equipment:

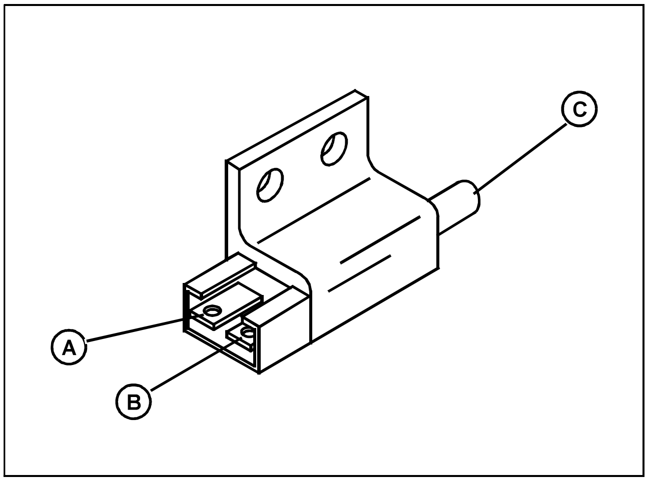
- Ohmmeter

Test Connections:

- Set ohmmeter for 1X scale.

Procedure:

1. Remove connector from RIO switch.
2. Connect meter leads to pairs of switch posts and compare to specifications.



3. Press and release plunger (C) of switch.

Specifications:

Switch plunger not pressed . Continuity between posts . . . . A and B
Switch plunger pressed. . No continuity between posts . . . . A and B

Results:

- If RIO switch does not pass both tests, replace switch.

Brake/Neutral Start Switch Test

Reason:

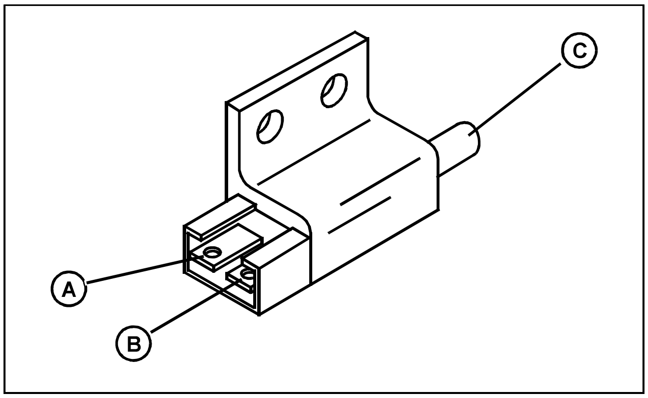
To determine proper operation of the brake/neutral start switch.

Equipment:

- Ohmmeter

Procedure

1. Remove connector from brake/neutral start switch.
2. Connect meter leads to pins of switch posts and compare to specifications.



3. Press and release plunger (C) of switch.

Specifications:

Switch plunger not pressed . . . . No continuity between posts A and B
Switch plunger pressed . . . . Continuity between posts A and B

Results:

- If brake/neutral start switch does not pass both tests, replace switch.

Fuel Shutoff Solenoid Switch Test

Reason:

To test proper operation of fuel shutoff solenoid.

Test Equipment:

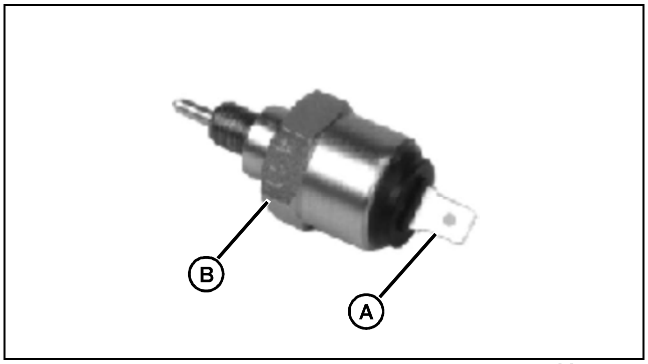
- 2 Jumper wires

Procedure:

CAUTION: Avoid Injury! Keep sparks, flame, or hot engine parts or personal injury can result.

1. Listen for an audible click when ignition switch is turned OFF to ON with PTO/RIP switch in the OFF position and either the seat switch pressed or park brake locked.
2. Is solenoid does not click, problem could be in equipment wiring.
3. Disconnect wire from fuel shutoff solenoid.

NOTE: If battery voltage drops below 9 volts when cranking engine or while engine is running, the solenoid will not function properly.



M82845

4. Connect a jumper wire from the battery positive (+) terminal to solenoid terminal (A).
5. If solenoid now clicks, the solenoid is working properly, problem is with the input signal wiring.
6. If solenoid does not click - go to next step.
7. Add a jumper wire from the battery negative (-) terminal to the solenoid body (B).

Results:

- If solenoid now clicks, the solenoid is working properly and problem is with the ground wiring.
- If solenoid does not click, replace solenoid.

Oil Pressure Switch Test

Reason:

To determine the proper operation of the oil pressure switch.

Equipment:

- Ohmmeter

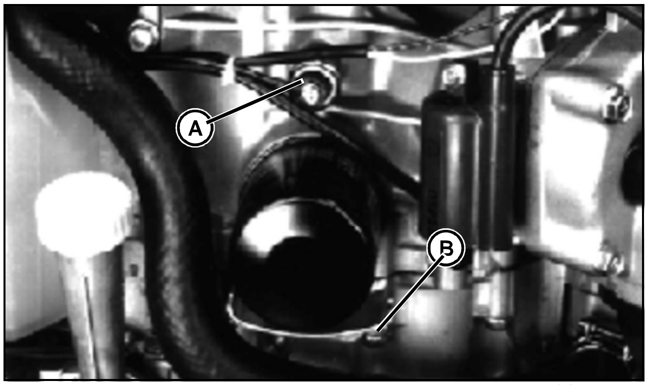
Procedure:

1. Park machine on a level surface.
2. Move forward/reverse pedals to NEUTRAL position.
3. Lock parking brake.
4. Turn key switch OFF.

5. Raise hood.

IMPORTANT: Avoid damage! Do not allow connector of wire to contact the engine or frame as there will be voltage at it during the test.

6. Disconnect wire from oil pressure switch. The oil pressure switch is located near the oil filter on all models.



M83239

LX279 Shown

7. Connect red ohmmeter lead to terminal of switch (A) and black ohmmeter lead to engine block (B).

8. Set ohmmeter for 1x scale.

9. Measure resistance between terminal and engine block. There SHOULD be continuity between terminal and ground.

10.Start

11.Start and run engine.

12.Measure resistance between terminal and engine block. There SHOULD NOT be continuity between terminal and ground.

Results:

NOTE: be sure to apply pipe sealant with TEFLON® to threads of switch anytime it is installed.

- If switch does NOT have continuity to ground when engine is not running, replace the switch.
- If the switch DOES have continuity to ground with the engine running, check engine oil pressure. If the oil pressure is to specifications, replace the switch.

Coolant Temperature Switch Test - LX279

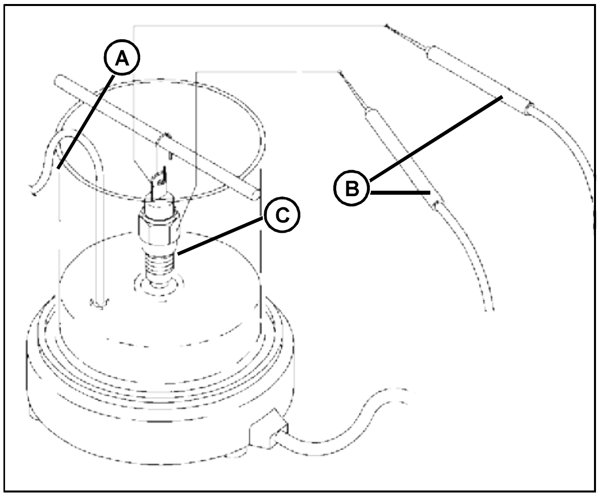
Reason:

To determine operating temperature of switch.

Equipment:

- Ohmmeter
- JT05800 Thermometer
- Glass Container
- Heating Unit

Procedure:



M99536

1. Connect ohmmeter leads (B) to switch terminal and body.
2. Suspend switch (C) in a container of engine coolant solution.
3. Place Digital Thermometer lead (A) in coolant.
4. Heat and stir the coolant. Observe temperature of coolant when continuity occurs. Continuity should occur when coolant temperature equals 111° C (232° F).

Results:

- If continuity does not occur within specification, replace switch.

RIO Switch Adjustment

Reason:

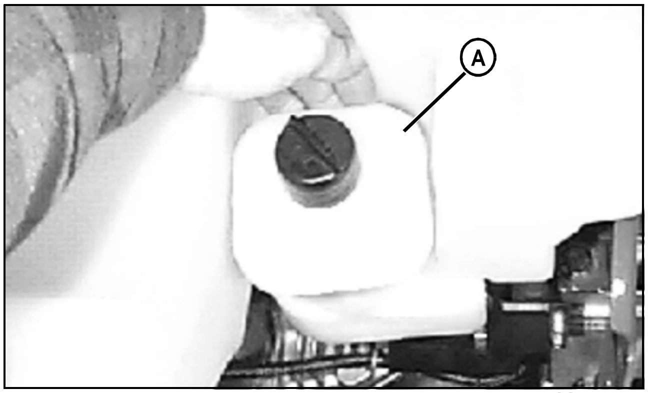
To set the proper air gap between the RIO switch and the pivot bracket so that the RIO switch is activated at the proper time.

Equipment:

- Feeler Gauge (Blade Type)

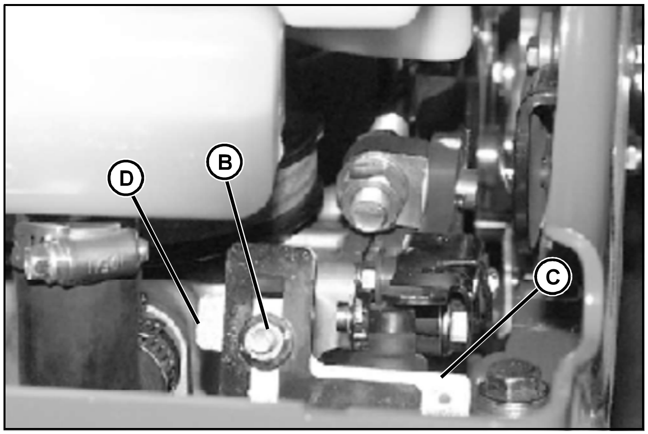
Procedure:

1. Park machine on a level surface.
2. Turn key switch OFF.
3. Move forward/reverse pedals to NEUTRAL position.
4. Move PTO/RIO switch to OFF position.
5. Lock parking brake.
6. Remove fender deck. See “Fender Deck Removal and Installation” on page 590 in the Miscellaneous section.
7. Remove the rosebud clip holding the fuel line to the frame rail.



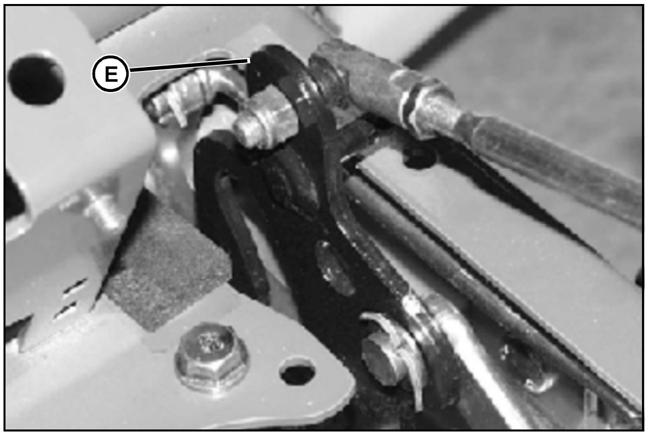
M95320

8. Unsnap the transaxle reservoir bottle (A) from the fuel tank and lift the fuel tank up and off of the frame. Set the fuel tank to the right side of the machine between the front and rear wheels.



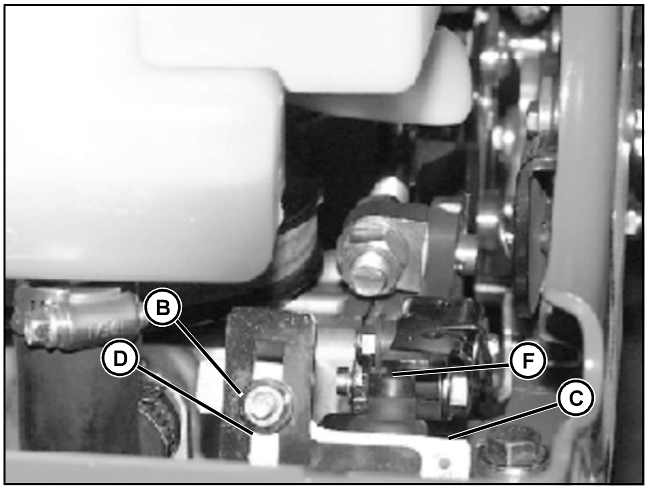
M95486

9. Loosen the M6 locknut (B) and slide the RIO switch and bracket assembly (C) all the way down in the slot (D).



M99607

10. Push down on top of pivot bracket (E) and cycle the control arm two (2) times in reverse direction.



M95486

11. Slide switch and bracket assembly (C) up in the slot (D) and set air gap (F) to 1 mm (0.04 in.).
12. Hold the switch and bracket assembly firmly in place and tighten the M6 locknut (B) to 6 N•m (54 lb-in.).
13. Reassemble the machine.
14. Set fuel tank back into position and snap transaxle reservoir bottle into fuel tank.
15. Route the fuel line back into position and snap rosebud clip back into frame rail.
16. Reinstall fender deck. See “Fender Deck Removal and Installation” on page 590 in Miscellaneous section.

Specifications:

Air Gap . . . . 1 mm (0.04 in.)

Adjustment Screw . . . . 6 N•m (54 lb-in.)

Electric PTO Clutch Test

Reason:

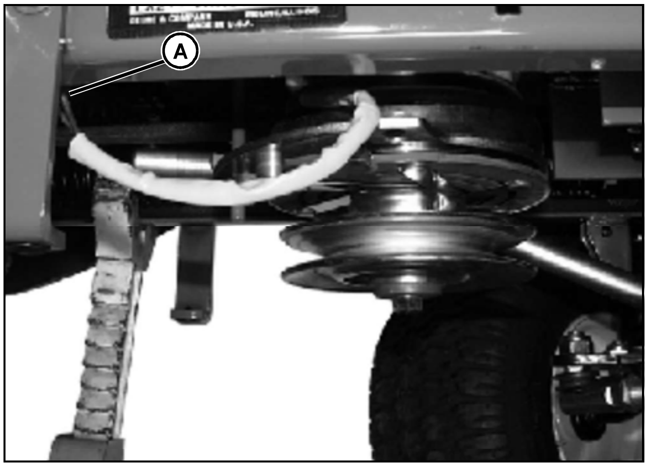
To check condition of PTO clutch coil and to check operation under load.

Equipment:

- Ohmmeter
- JT05712 Current Gun

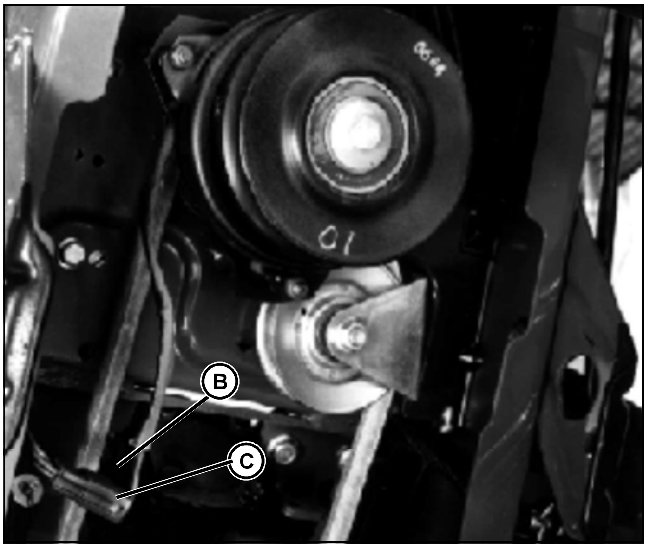
Procedure:

1. Park machine on a level surface.
2. Move forward/reverse pedals to NEUTRAL position.
3. Lock parking brake.
4. Turn key switch OFF.
5. Remove mower deck. (See procedure in Attachments section.)
6. Disconnect PTO clutch connector.
7. Set ohmmeter for 1x ohms scale.



M99547

8. Measure resistance across terminals of the connector (A). Resistance should measure 2.4 - 2.7 ohms.



M82910

9. Connect PTO clutch connector (C).
10. Put JT05712 Current Gun over blue PTO clutch wire (B).
11. Start and run engine at slow idle.
12. Turn the PTO/RIP switch to the ON position.
13. Measure PTO clutch current draw. The current draw should be 4 amps.

Results:

- If resistance does not meet specifications, replace the PTO clutch.
- Normal current draw is approximately 4 amps. Low current draw will cause a weak PTO clutch. If the current draw is less than 3 amps, replace clutch.

Repair

Electric Clutch Removal and Installation

Reason:

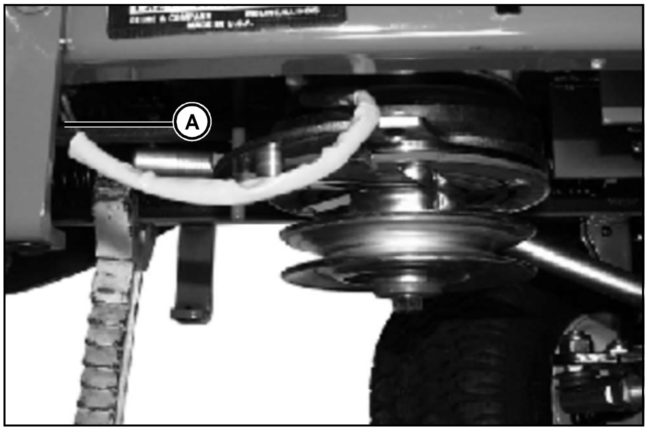
To check the condition of the PTO clutch coil and to check operation under load.

Test Equipment:

- Ohmmeter
- JT05712 Current Gun

Procedure:

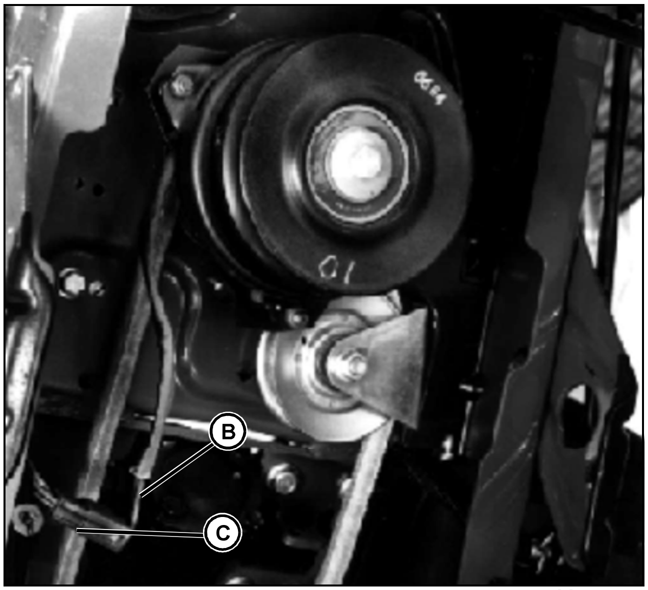
1. Park machine on a level surface and turn engine OFF.
2. Disconnect negative (-) battery cable at battery.
3. Remove spark plug wires to prevent accidental starting of engine during procedure.
4. Remove mower deck.
5. Raise and support front of machine on suitable stands.



M99547

6. Disconnect clutch wiring connector (A) from main wiring harness.

CAUTION: Avoid injury! Clutch will fall off crankshaft when bolt is removed. Support clutch during removal.



M82910

7. Hold the engine from spinning by using a 35 mm wrench on the flat sides of the spacer washer (B).
8. Remove bolt and washer (C) and clutch from crankshaft.

Installation:

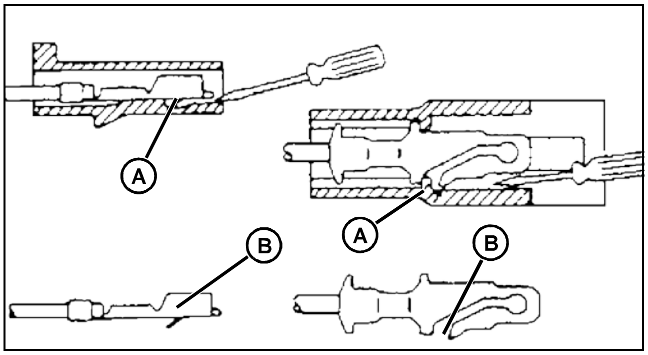
1. Apply MPG-2® Multi-Purpose Grease to engine crankshaft before installing clutch.
2. Install clutch on crankshaft with pin (D) through slot in clutch coil housing. Ensure fixed key in clutch slides into crankshaft keyway (E).
3. Install washer with concave side toward PTO clutch.
4. Install bolt and tighten to 75 N•m (55 lb-ft).
5. Connect PTO clutch connector to main wiring harness.
6. Remove machine from stands and reconnect spark plug wires.
7. Follow new clutch break-in procedures.

New Clutch Break In Procedures:

1. Park machine on level surface.
2. Move Forward/Reverse pedals to NEUTRAL position.
3. Lock parking brake.
4. Start engine.
5. Set throttle control to half-speed.
6. Turn PTO/RIP switch ON and OFF 8 - 10 times in 4 - 5 second intervals at no-load.

Connector Body - Blade Terminals

Replacement:



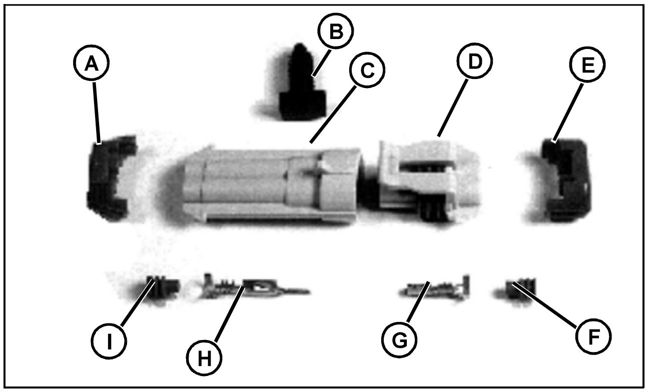
RW4218

1. Use a small screwdriver to depress locking tang (A) terminal. Slide connector body off.

2. Be sure to bend locking tang back to its original position (B) before installing connector body.

Metripack® Connector

Removal:



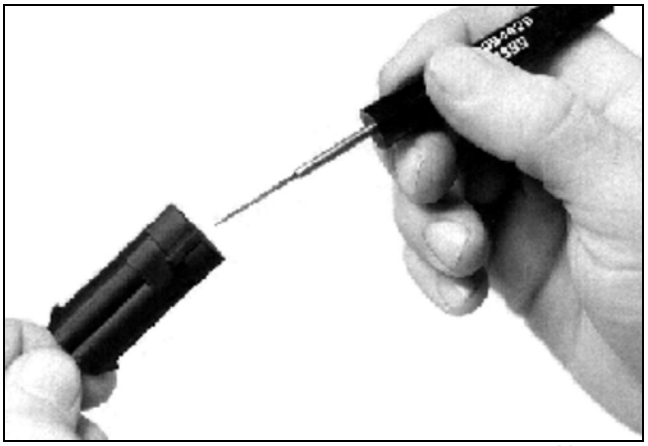
M56685

A - Wire Retainer
B - Mounting Post 9optional)
C - Pin Body
D - Sleeve Body
E - Wire retainer
F - Shure-Seal
G - Sleeve
H - Pin
I - Shure-Seal

NOTE: Identify wire number/color locations with connector terminal letters.

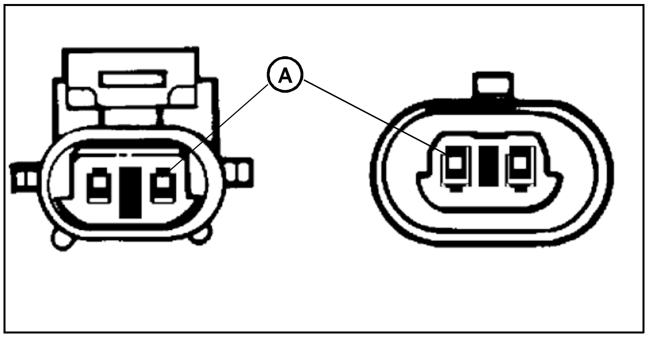
1. Open connector body.

2. Remove retainer on wire end of connector with a screwdriver.



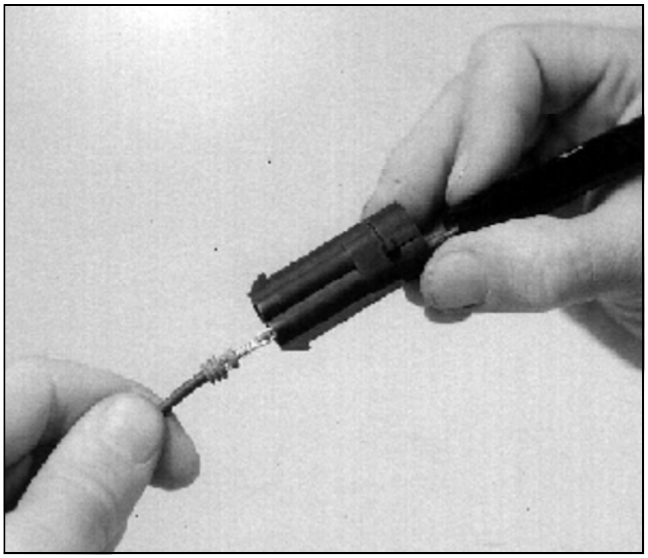
M56690

3. Use JDG777 Terminal Removal Tool to remove contact from connector body.



M56691

NOTE: To remove sleeve connector from sleeve body (short connector half) insert tool in slot between terminal contact and connector body. To remove pin connector from pin body (long connector half) insert tool in center of contact (A).

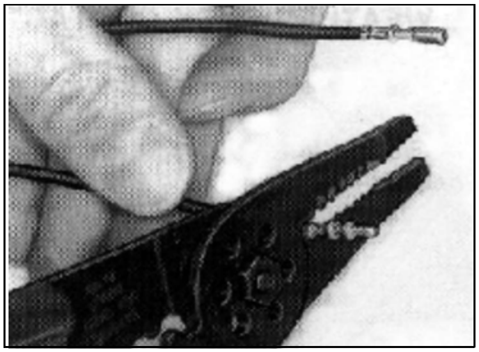


M56689

4. Hold the removal tool fully seated and pull wire from connector body.

Replacement:

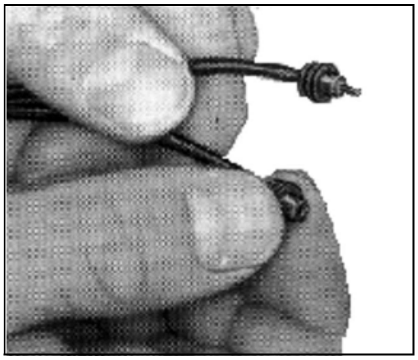
1. Remove wire from connector body as described above.



TSO132

2. Use JDG145 Universal Electrical Plier to remove wire as close as possible to old contact.

IMPORTANT: Avoid damage! METRIPACK® connectors are keyed A, B, C, etc. for proper contact mating. Be sure contacts and wire color/numbers match and are in proper alignment.



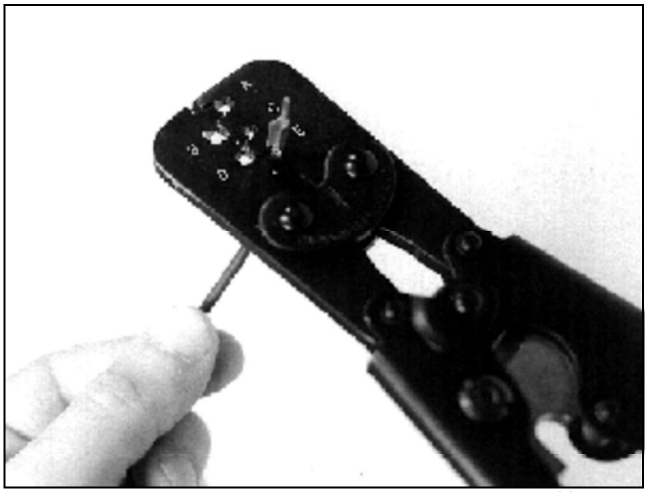
TSO136

3. Install correct size cable seal on wire.

NOTE: Cable seals are available for three sizes of wire.

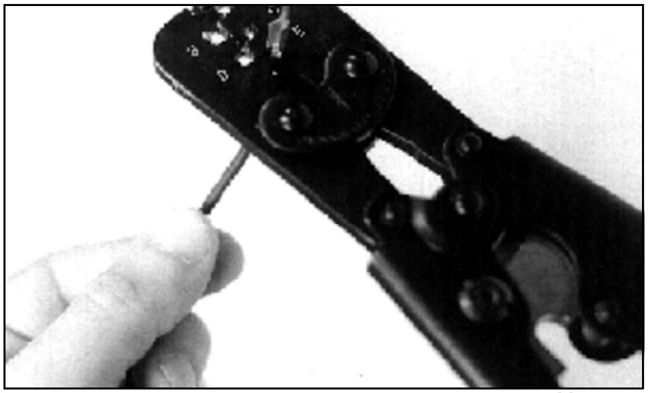
4. Strip insulation from wire to expose 6 mm (1/4 in.) and align cable seal with edge of insulation.

- Large: 1.0 mm (16 gauge) wire
- Medium: 0.8 mm (18 gauge) wire
- Small: 0.5 mm (20 gauge) wire



M56686

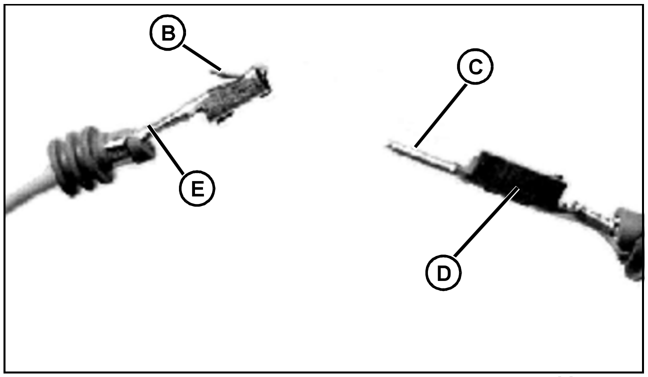
5. Place proper size contact on wire and use JDG776 Crimper to crimp contact in place with a “W” type crimp.



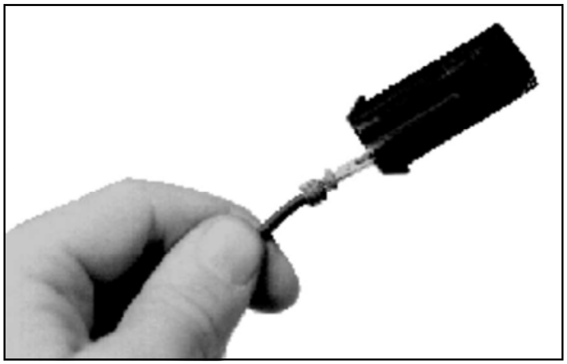
M56686

6. Use JDG776 Crimper to secure cable seal to contact as shown.

IMPORTANT: Avoid damage! Proper barb (B) location and orientation for installation of sleeve (E) and pin (C) is shown (E).



M56688

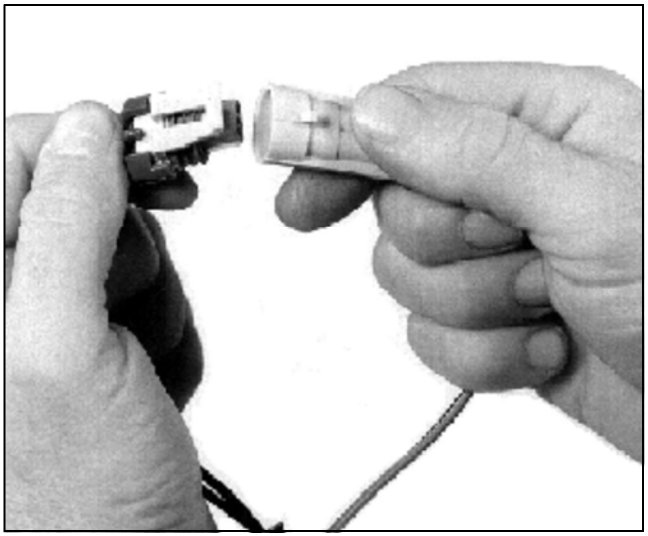


M56689A

7. Push contact into new connector body until fully seated.

8. Pull on wire slightly to be certain terminal is locked in place.

9. Install wire retainer.



M56683

10.Transfer remaining wires to correct terminal in new connector.

11.Place retainer on wire end of connector and snap in place.

12.Close connector body.

Starting Motor

Analyze Condition:

NOTE: Starter repair is limited to brushes, end caps, and starter drive. Fields in starter are permanent magnets and are not serviceable. If housing or armature is damaged, replace starter.

The starter overheats because of:

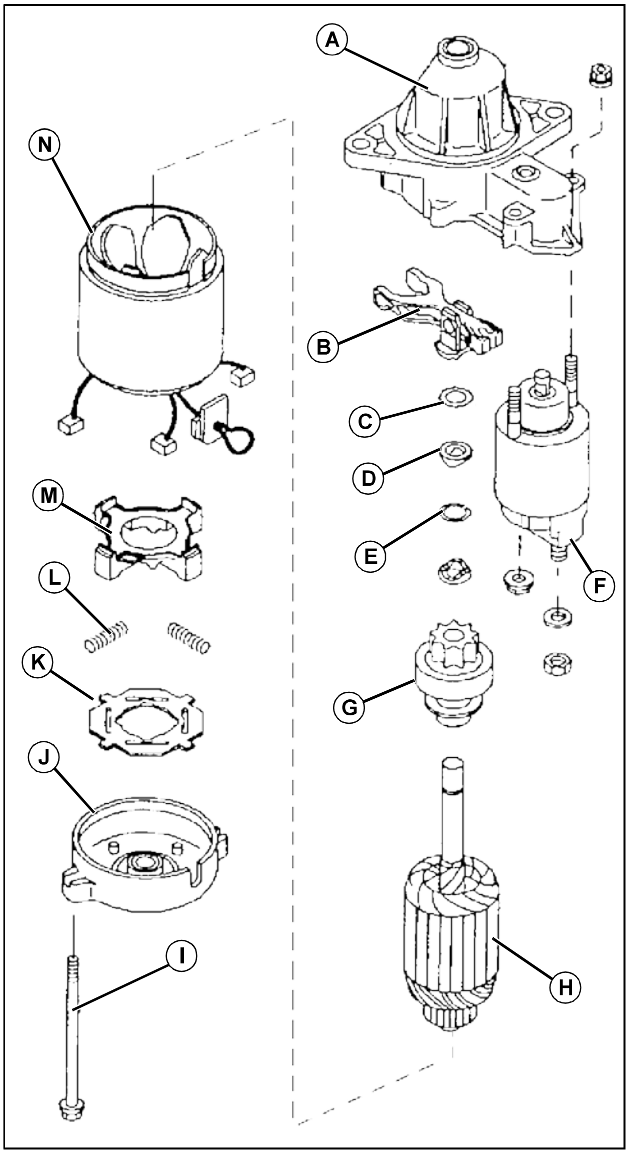
- Long cranking
- Armature binding

The starter operates poorly because of:

- Armature binding
- Dirty or damage starter drive
- Badly worn brushes or weak brush springs
- Excessive voltage drop in cranking system
- Battery or wiring defective
- Shorts, opens, or grounds in armature

Kawasaki FD501V Engine - Starting Motor

Disassembly/Assembly:



M83316A

A - Front Cover
B - Shift Lever
C - Washer
D - Pinion Stopper Half (2 used)

E - Retaining Clip
F - Solenoid
G - Pinion
H - Armature
I - Retaining Bolt (2 used)
J - End Cover
K - Insulator
L - Brush Spring (4 used)
M - Brush Holder
N - Case with Field Windings and Brushes

1. Mark body and covers to aid in alignment for assembly.
2. Separate pinion stopper halves to remove retaining clip to remove starter drive.
3. Inspect parts for wear or damage.
4. Test solenoid, starter armature and case with field windings and brushes. See "Inspection/Test:" procedure below.

Assembly:

- Assembly is done in the reverse order of removal.

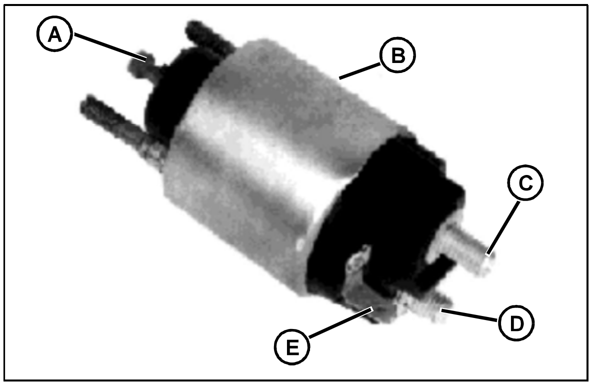
Apply a very light coating of multipurpose grease to:

- Sliding surfaces of armature and solenoid shift lever pivots.
- Armature shaft spline.
- Points where shaft contacts cover.

Always replace retaining clip with new.

Inspection/Test:

1. Measure brush lengths. If any one brush length is less than 6 mm (0.240 in.), replace case with field windings and brushes.
2. Inspect brush springs for wear or damage. Replace if necessary.

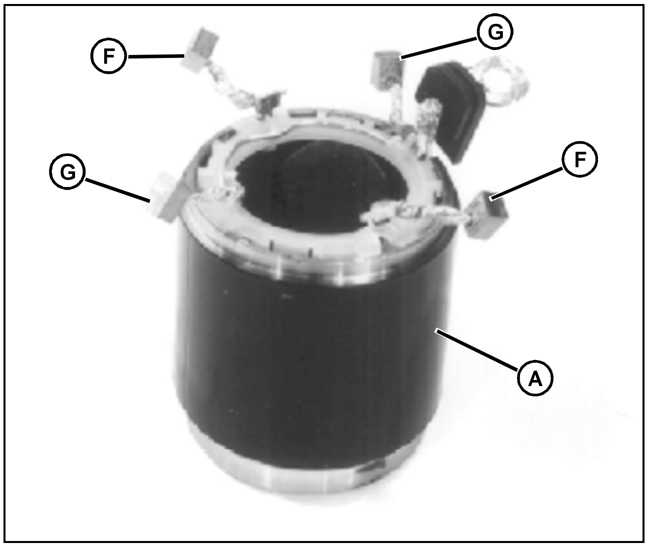


M51705

3. Test solenoid:

- Check solenoid terminals (C and D) for continuity. There should be no continuity.
- Depress switch arm (A). There should be continuity when arm is fully depressed.
- Test for open circuits between terminal (D) and tang (E). There should be no continuity.
- Test for open circuits between tang (E) and body (B). There should be no continuity.

If solenoid fails any test, it is defective and must be replaced.



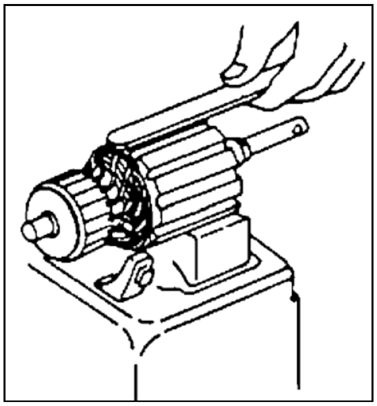
m83317

4. Test case with field windings and brushes:

- Test for open circuits between brushes (G), then (F) for continuity. There should be continuity.
- Test for open circuits between brushes (G), then (F) for continuity. There should be continuity.
- Check either brush (G) to non-painted area of case (H) for continuity. There should be no continuity.
- Check either brush (F) to non-painted area of case (H) for continuity. There should be continuity.

5. Test starter armature:

IMPORTANT: Avoid damage! Do not clean armature with solvent. Solvent can damage insulation on windings. Use only mineral spirits and a brush.

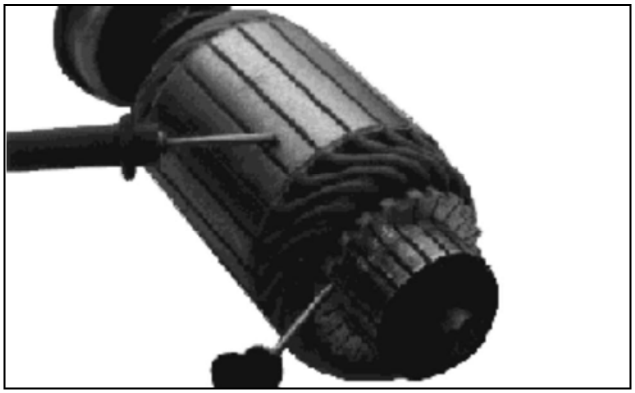


M24861

- Locate short circuit by rotating armature on a growler while holding a hacksaw blade or steel strip on armature. The hacksaw blade will vibrate in area of short circuit.

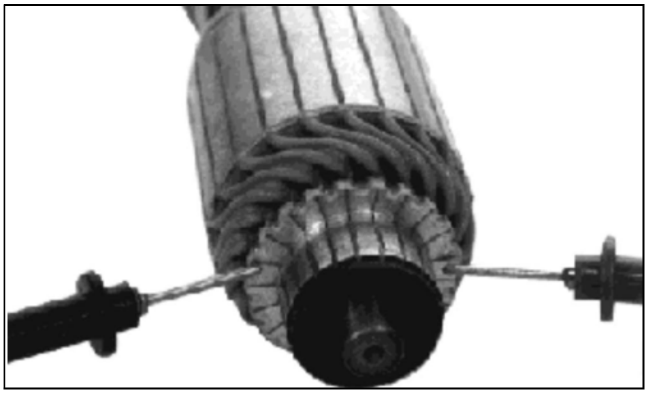
NOTE: Shorts between bars are sometimes caused by dirt or copper between bars. Inspect for this condition.

- If test indicates shorted circuit windings, clean commutator of dust and filings. Check armature again. If test still indicates a short circuit, replace armature.



M50112

6. Test for grounded windings using an ohmmeter:
   - Touch probes on each commutator bar. Armature windings are connected in parallel, so each commutator bar must be checked.
   - If test indicates continuity, a winding is grounded and the armature must be replaced.

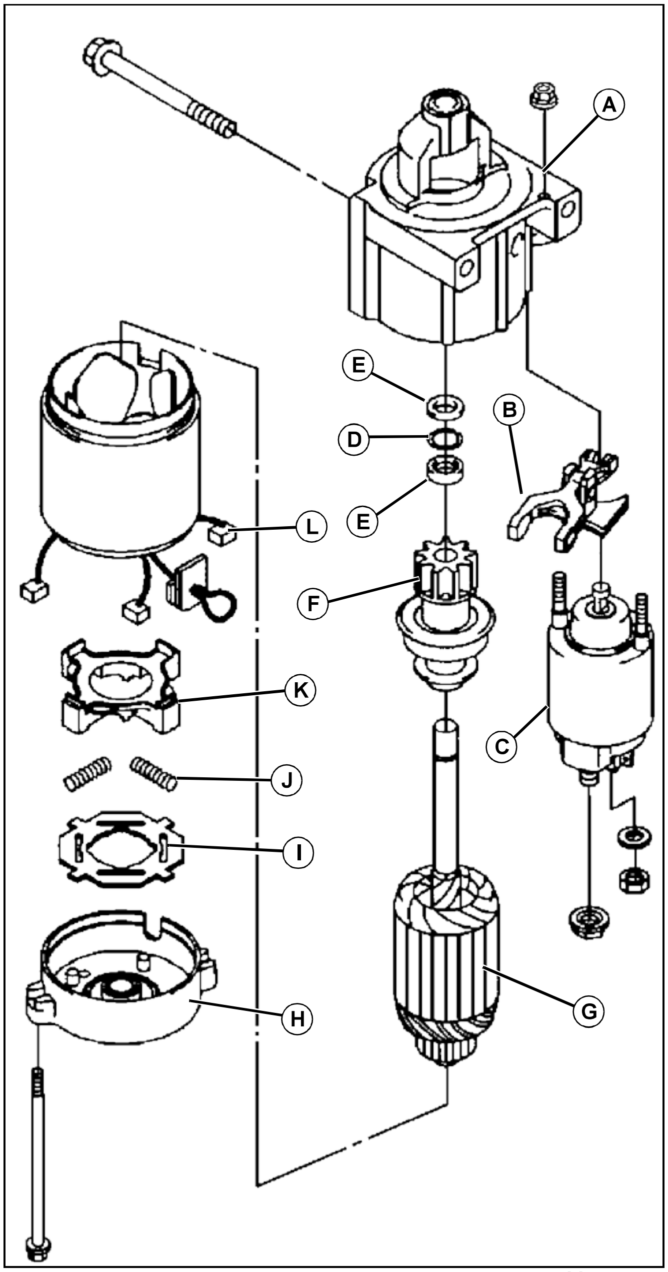


M50113

7. Test for open circuit windings using an ohmmeter:
   - Touch probes on two different commutator bars. If test shows no continuity, there is an open circuit and the armature must be replaced.

Kohler, Kawasaki FH500V/FH580V, and B&S Engines - Starting Motor

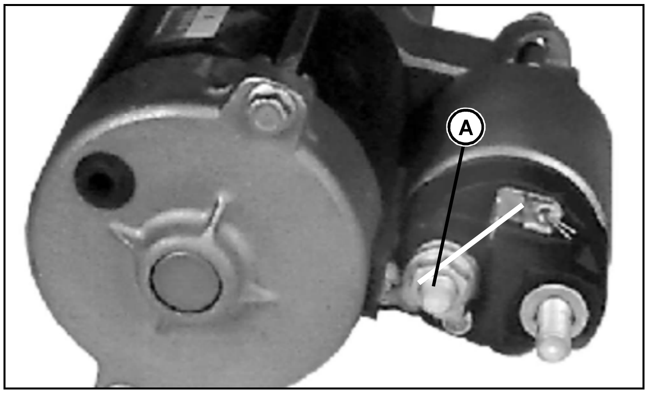
Disassembly:



M94902

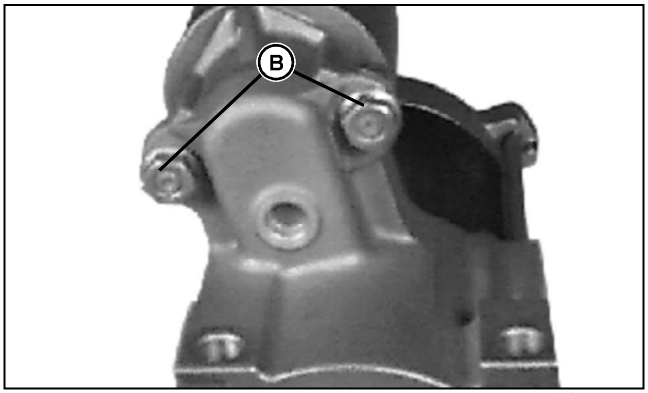
A - Front Cover
B - Shift Lever
C - Solenoid
D - Retaining Clip
E - Pinion Stopper
F - Pinion
G - Armature
H - End Cover
I - Insulator
J - Brush Springs
K - Brush Holder
L - Brush

NOTE: Check for available service parts before disassembling motor.



M95075

1. Remove nut (A) securing braided copper wire to solenoid.
2. Slide wire off of solenoid lug.

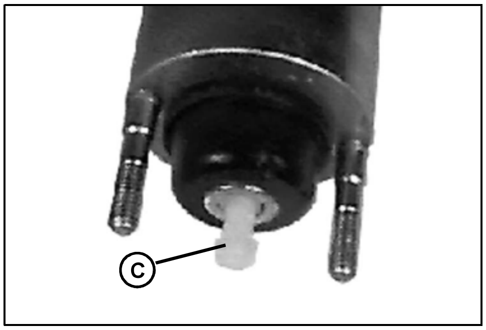


M95076

3. Remove nuts (B) from solenoid mounting bolts.

NOTE: Solenoid plunger is hooked over solenoid shift lever in starting motor housing.

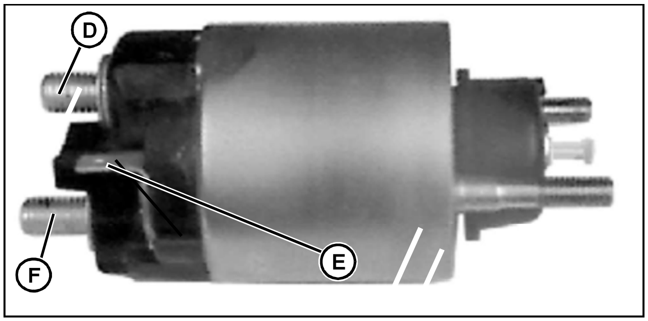
4. Slide solenoid out of staring motor housing and lift away from starting motor housing to remove plunger from shift lever.



M95078

5. Inspect plunger (C) for wear or damage. Press plunger into solenoid to check spring compression and freedom of movement.

6. If the solenoid plunger is broken, does not move freely, or there is little or no spring tension, replace the solenoid.



M95077

7. Using a multimeter or ohm meter, check the following for correct resistance:

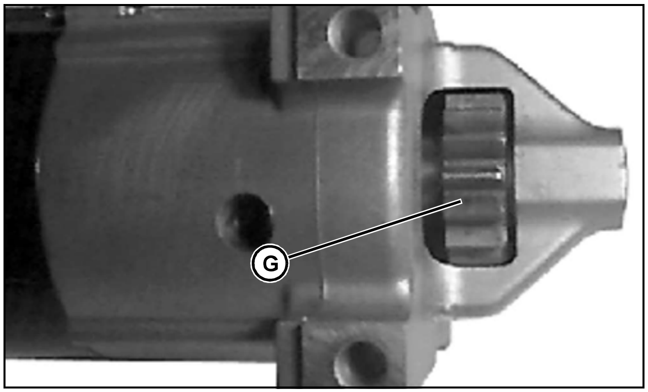
D to F . . . . .No Continuity

F to E . . . . .No Continuity

D to E . . . . Less than 1 ohm

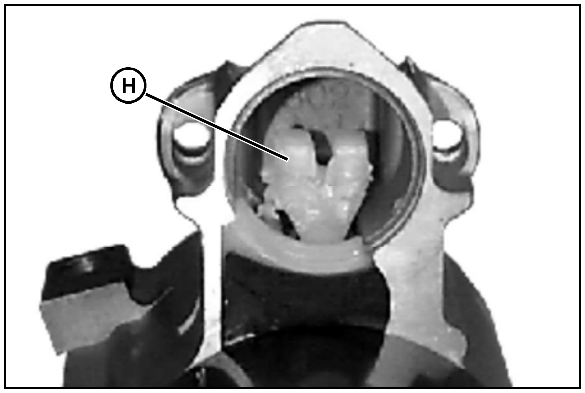
D and E to solenoid housing . . . . 1 to 2 ohms

8. If the resistance measured is not correct, replace the solenoid.



M95083

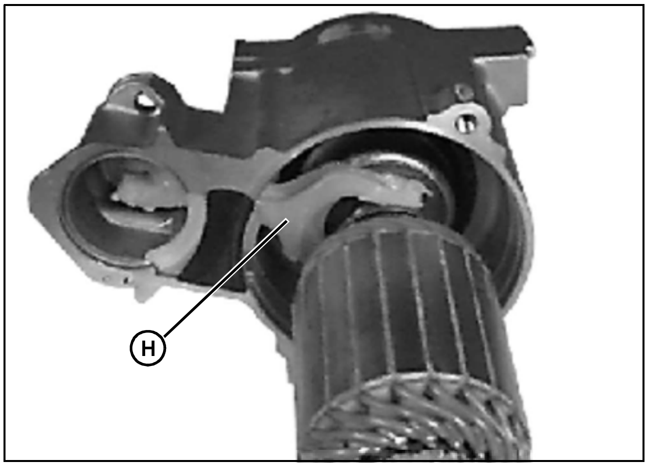
9. Inspect starting motor pinion gear (G). The pinion gear should rotate and slide on the armature shaft smoothly.



M95084

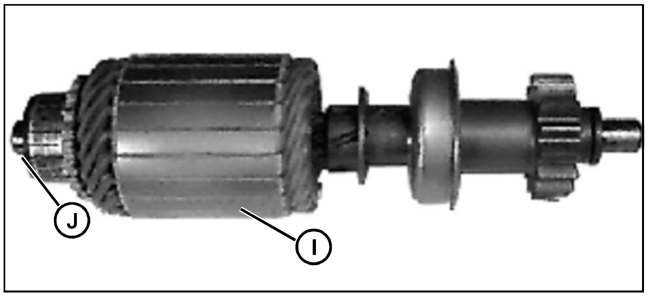
10.Inspect the shift lever (H) for damage. Ensure that shift lever operates pinion gear. If the shift lever is damaged or does not move the pinion gear in and out of starting motor, replace the lever.

11.Remove the two bolts securing the starting motor housing halves together. Slide the armature housing off of the starting motor.



M95079

12.Remove the shift lever (H) and pivot.



M95080

13.Remove the armature assembly (I) from starting motor housing

IMPORTANT: Avoid damage! DO NOT use emery cloth to clean the commutator (J). The particles from the cloth will become embedded in the commutator and cause rapid brush wear.

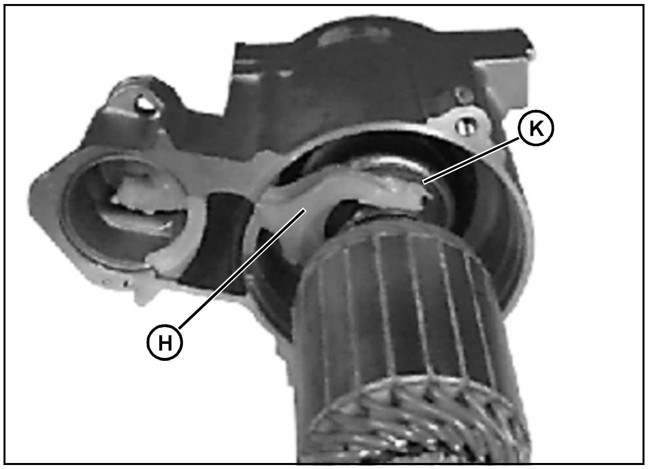
NOTE: The armature should not be soaked in a cleaning solution. Fine sandpaper, such as crocus cloth, can be used to clean the armature.

14.Check the brushes should for proper seating, weak brush springs, dirt, oil or corrosion.

- When all parts have been thoroughly cleaned, lightly lubricate the bearings with #20 oil.

Assembly:

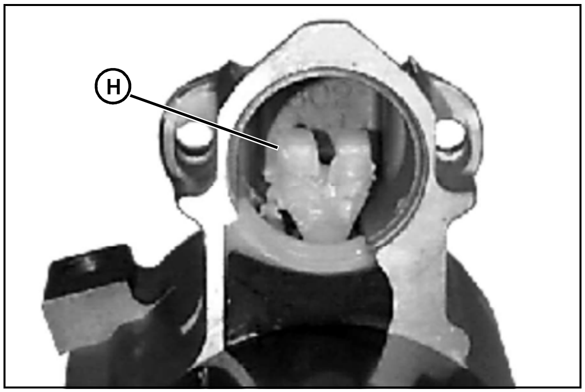
1. Place armature in housing end.



M95079

2. Install shift lever (H). Ensure shift lever fork is seated in pinion gear shift collar (K).

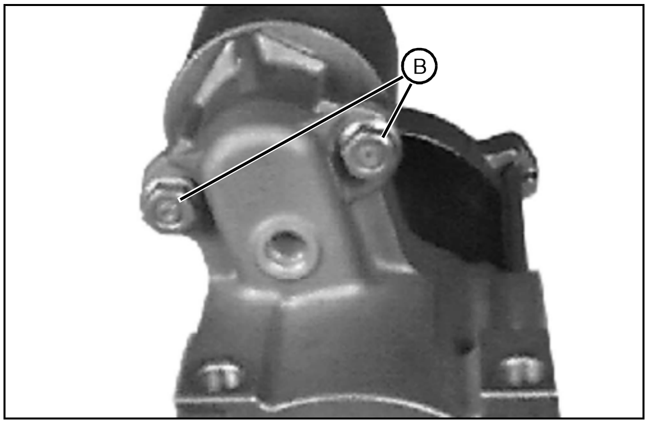
3. Install armature housing, brush housing and end cap over armature. Secure with two long cap screws



M95084

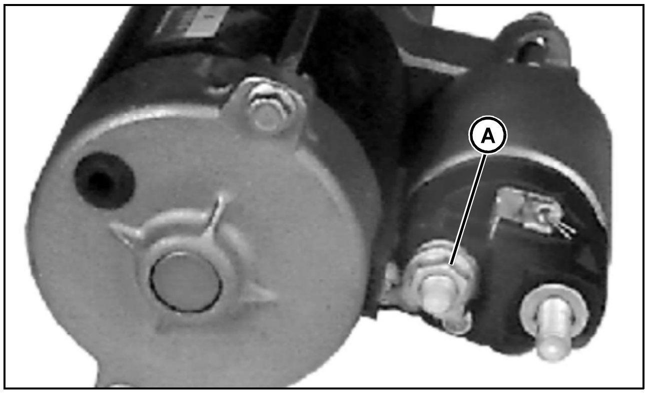
4. Liberally lubricate shift lever (H) with grease.

5. Install solenoid to starting motor. Ensure solenoid plunger seats over shift lever fork.



M95076

6. Secure solenoid with two nuts (B).



M95075

7. Carefully slide braided copper wire over solenoid lug. Secure wire to lug with flange nut (A).

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POWER TRAIN - HYDROSTATIC SPECIFICATIONS

Specifications

General Specifications

Drive Train	Belt Drive Transaxle with foot-controlled variable speed drive
Transmission Control	Twin Touch™ Automatic
Hand Control	Optional
Cruise Control	Standard
Transaxle	Kanzaki K62A
Transaxle (LX277 AWS)	Kanzaki K62B
Transaxle Oil Capacity	2.5 L (2.7 qt)
Travel Speed-Forward	0 - 8.8 km/h (0 - 5.5 mph)
Travel Speed-Reverse	0 - 4.8 km/h (0 - 3.0 mph)

Tests and Adjustments Specifications

Reverse Pedal-to-Footmat	50 ± 2 mm (1.97 ± 0.08 in.)

Repair Specifications

Transaxle Oil Capacity	2.5 L (2.7 qt)
Reservoir Oil Top Off Capacity	0.47 L (0.5 qt)

Reduction Gear Assembly:

Reduction Pinion Gear ID	15.04 mm (0.592 in.)
Reduction Shaft OD	14.99 mm (0.590 in.)
Reduction Pinion Gear/Shaft Clearance	0.09 - 0.19 mm (0.003 - 0.007 in.)
(Wear Limit)	0.50 mm (0.020 in.)

Differential Gear Assembly:

Pinion Gear ID (New)	15.03 - 15.13 mm (0.592 - 0.596 in.)
Pinion Shaft OD (New)	14.90 - 14.98 mm (0.587 - 0.590 in.)
Pinion Gear/Shaft Clearance	0.05 - 0.23 mm (0.002 - 0.009 in.)
(Wear Limit)	0.50 mm (0.020 in.)

Axle Shaft (Right Hand and Left Hand):

Case Bushing ID (Press Fit in Upper Case)	25.505 - 25.585 mm (1.004 - 1.007 in.)
Axle Bushing ID	25.381 - 25.525 mm (0.999 - 1.005 in.)
Axle Shaft OD	25.301 - 25.355 mm (0.996 - 0.998 in.)
Clearance Wear Limit (Maximum)	0.50 mm (0.020 in.)

Swash Plate/Shift Block Clearance:

Standard	0.01 - 0.11 mm (0.0004 - 0.004 in.)
Wear Limit	0.15 mm (0.006 in.)

Thrust Plate:

Thickness	1.45 - 1.55 mm (0.057 - 0.061 in.)
(Wear Limit)	1.30 mm (0.051 in.)

Brake Shoe to Brake Disk Clearance	0.8 - 1.3 mm (0.03 - 0.05 in.)

Torque Specifications

Drain Bolt	**14.7 N•m (130 lb-in.)**
Center Case Cap Screw	**43 N•m (32 lb-ft)**

Case Half Cap Screw

Same Case	**24 N•m (205 lb-in.)**
New Case	**29 N•m (252 lb-in.)**

Transaxle-to-Frame Mounting Nut	**27 N•m (240 lb-in.)**
Transaxle Fan Nut	**30 N•m (22 lb-ft)**
Rear Wheel Bolts (AWS)	**55 N•m (41 lb-ft)**
Rear Tie Rod End Locknut	**60 N•m (44 lb-ft)**

Tools and Materials

Other Materials

Other Material

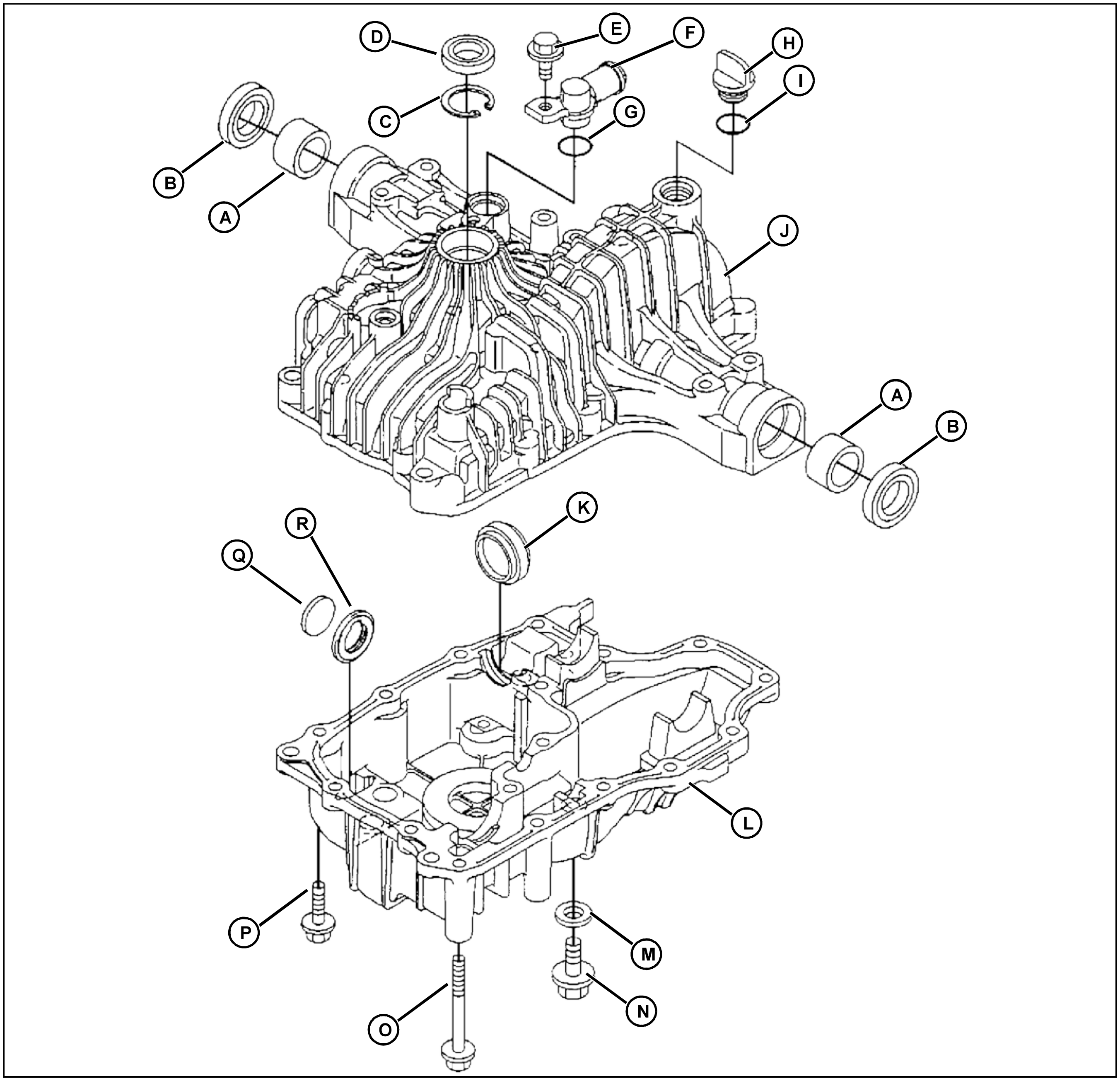
Part No.	Part Name	Part Use
TY6305	John Deere Clean and Cure Primer	Cleans parts and speeds cure of sealant.
TY6304 / TY9484	Flexible Sealant	Seals transaxle Case
TY9375 / TY9480 (#592 Loctite)[1]	Pipe Sealant with Teflon® (Medium Strength)[2]	Seal Pipe Plug
TY6305/TY9485 (#764 Loctite)	Cure and Clean Primer	Cleans Transaxle case mating surfaces

1. Loctite is a registered trademark of the Loctite Corp.

2. Teflon is a registered trademark of the DuPont Co.

Component Location

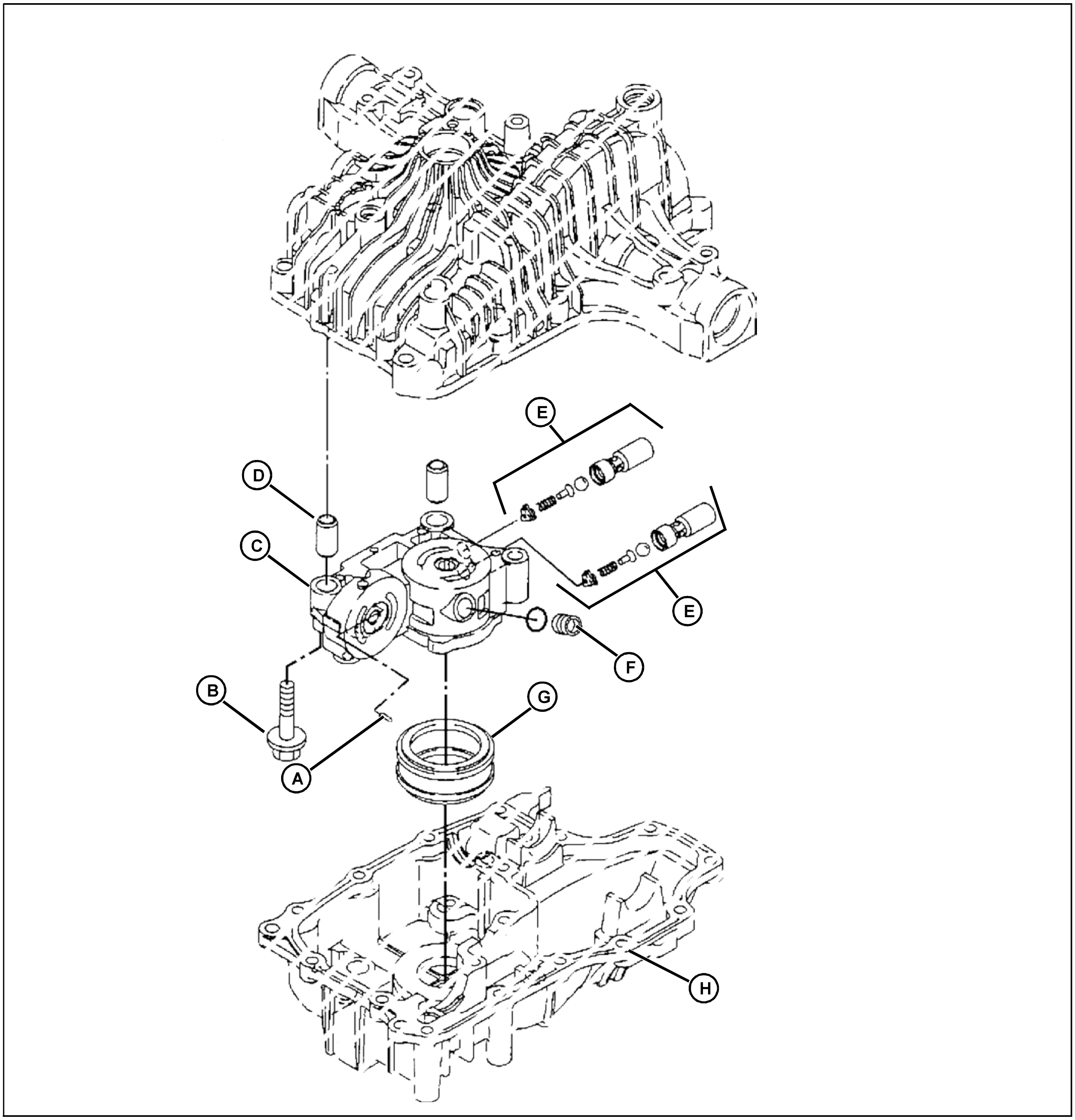
Transaxle Case Halves



M94894

- **A - Bushing (Pressed In)**
- **B - Seal**
- **C - Snap Ring**
- **D - Seal**
- **E - Cap Screw**
- **F - Reservoir Fitting**
- **G - O-Ring**
- **H - Oil Fill Cap**
- **I - O-Ring**
- **J - Upper Case Housing**
- **K - Filter**
- **L - Lower Case Housing**
- **M - Washer Seal**
- **N - Cap Screw**
- **O - Cap Screw**
- **P - Cap Screw**
- **Q - Magnet**
- **R - Magnet Cover**

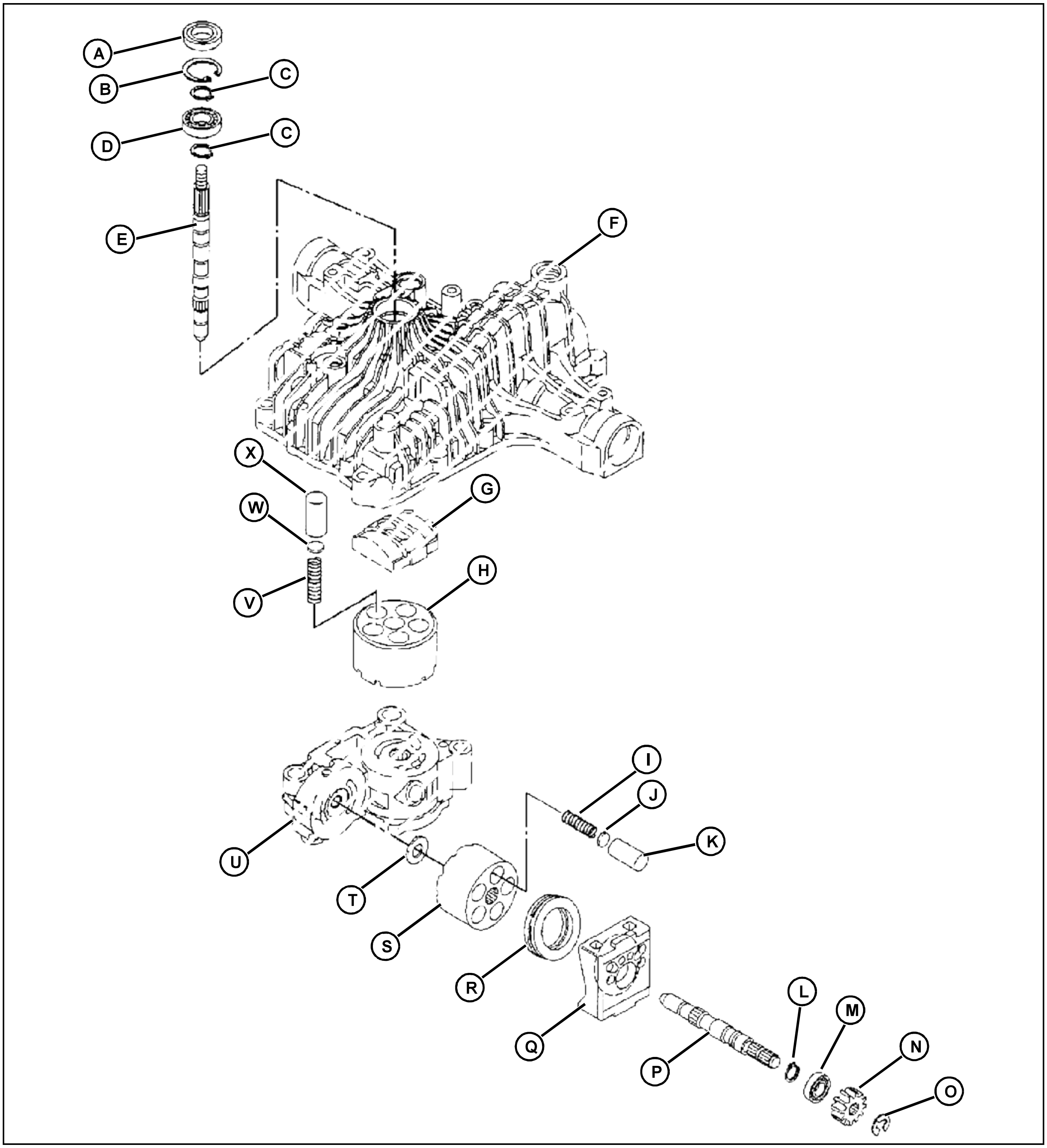
Center Case and Valves



M99731

A - **Pin**
B - **Cap Screw**
C - **Center Case**
D - **Bushing**
E - **Check Valve**
F - **Plug**
G - **Filter**
H - **Lower Case Housing**

Motor and Piston Pump

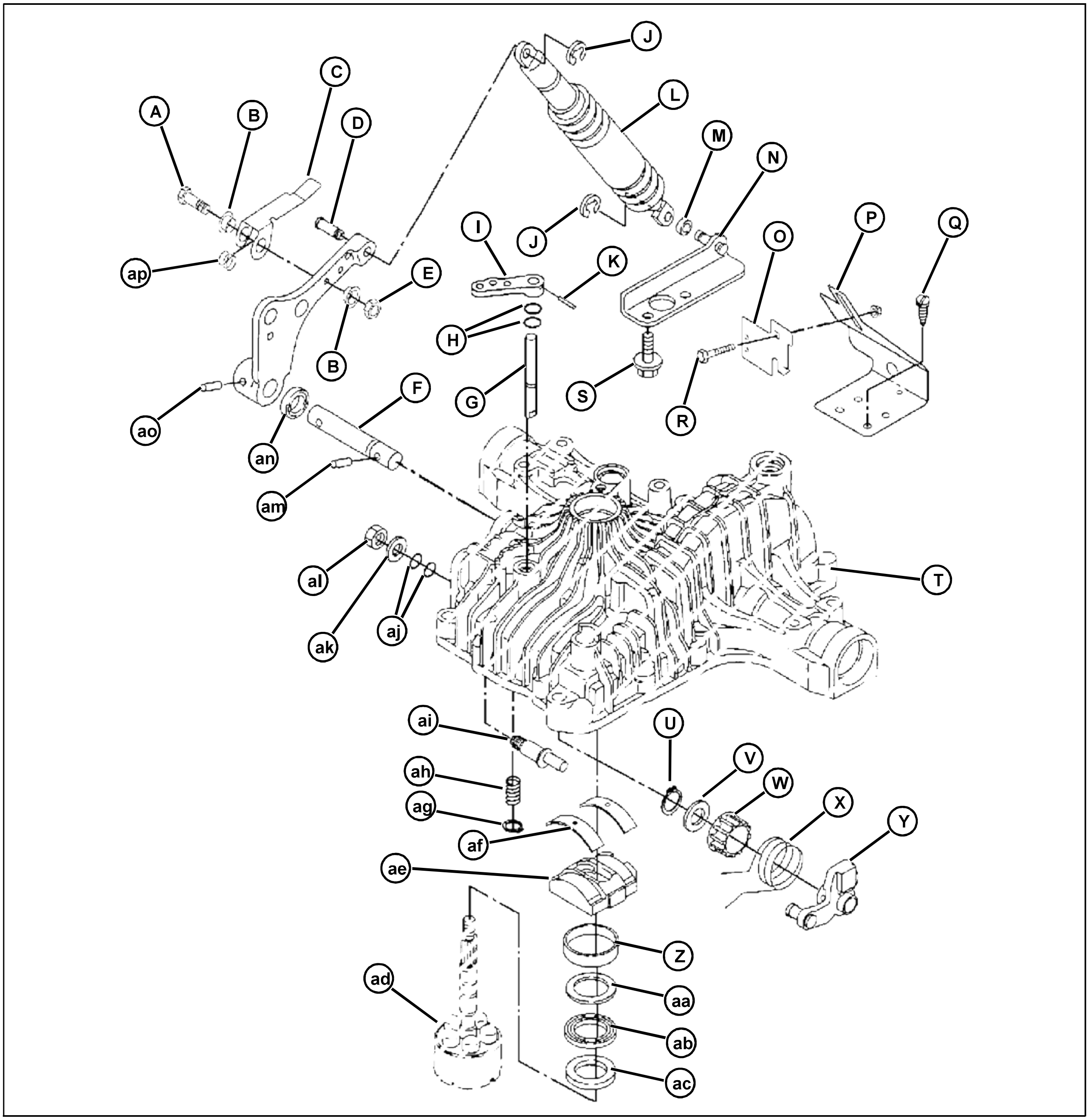


M99732

A - Bearing
B - Snap Ring
C - Snap Ring
D - Bearing
E - Input Shaft
F - Upper Case Housing
G - Swash Plate
H - Cylinder Block
I - Spring
J - Washer
K - Piston
L - Snap Ring
M - Bearing

N - Gear	T - Thrust Washer
O - E-Clip	U - Center Case
P - Output Shaft	V - Spring
Q - Bearing Housing	W - Washer
R - Bearing	X - Piston
S - Cylinder Block	

Control Shaft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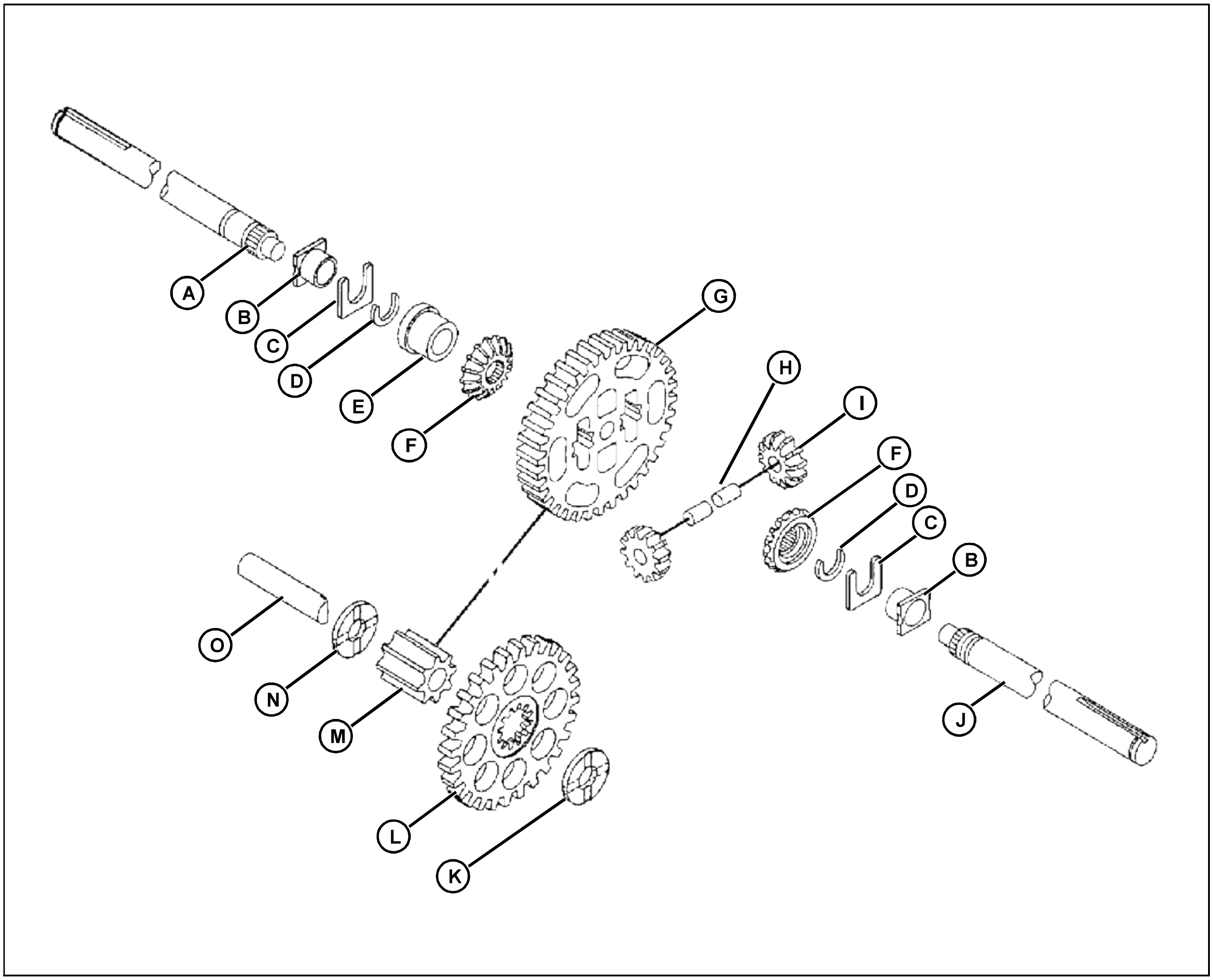
M99733

A - Cap Screw

B - Bushing
C - Lever

D - Pin
E - Nut
F - Shaft
G - Shaft
H - O-Rings
I - Freewheeling Lever
J - E-Clip
K - Spring Pin
L - Shock Absorber
M - Spacer
N - Bracket
O - Bracket
P - Bracket
Q - Screw
R - Cap Screw
S - Cap Screw
T - Center Case
U - Snap Ring
V - Washer
W - Collar
X - Spring
Y - Control Arm
Z - Bushing
AA- Thrust Plate
AB- Bearing
AC- Thrust Plate
AD- Rotating Group
AE- Swash Plate
AF- Thrust Bearing
AG- Snap Ring
AH- Spring
AI - Eccentric
AJ- O-Rings
AK- Washer
AL- Nut
AM- Spring Pin
AN- Seal
AO- Spring Pin
AP- Spring

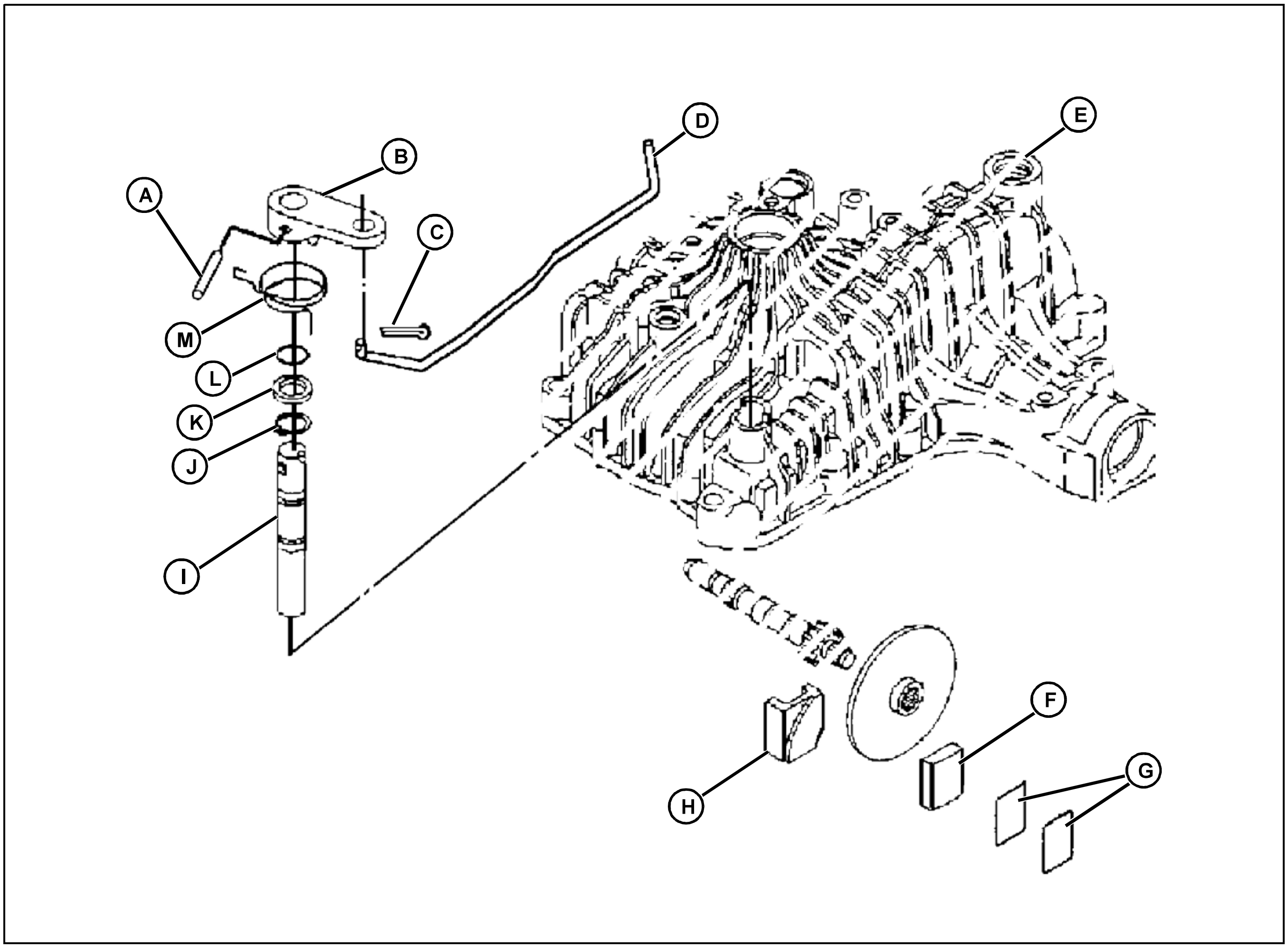
Reduction Gears, Differential, and Axles



M99734

- **A - Right Axle Shaft**
- **B - Bushing**
- **C - Thrust Washer**
- **D - C-Ring**
- **E - Spacer**
- **F - Side Gear**
- **G - Ring Gear**
- **H - Pinion Shaft**
- **I - Pinion Gear**
- **J - Left Axle Shaft**
- **K - Washer**
- **L - Reduction Gear**
- **M - Reduction Pinion**
- **N - Washer**
- **O - Pinion Shaft**

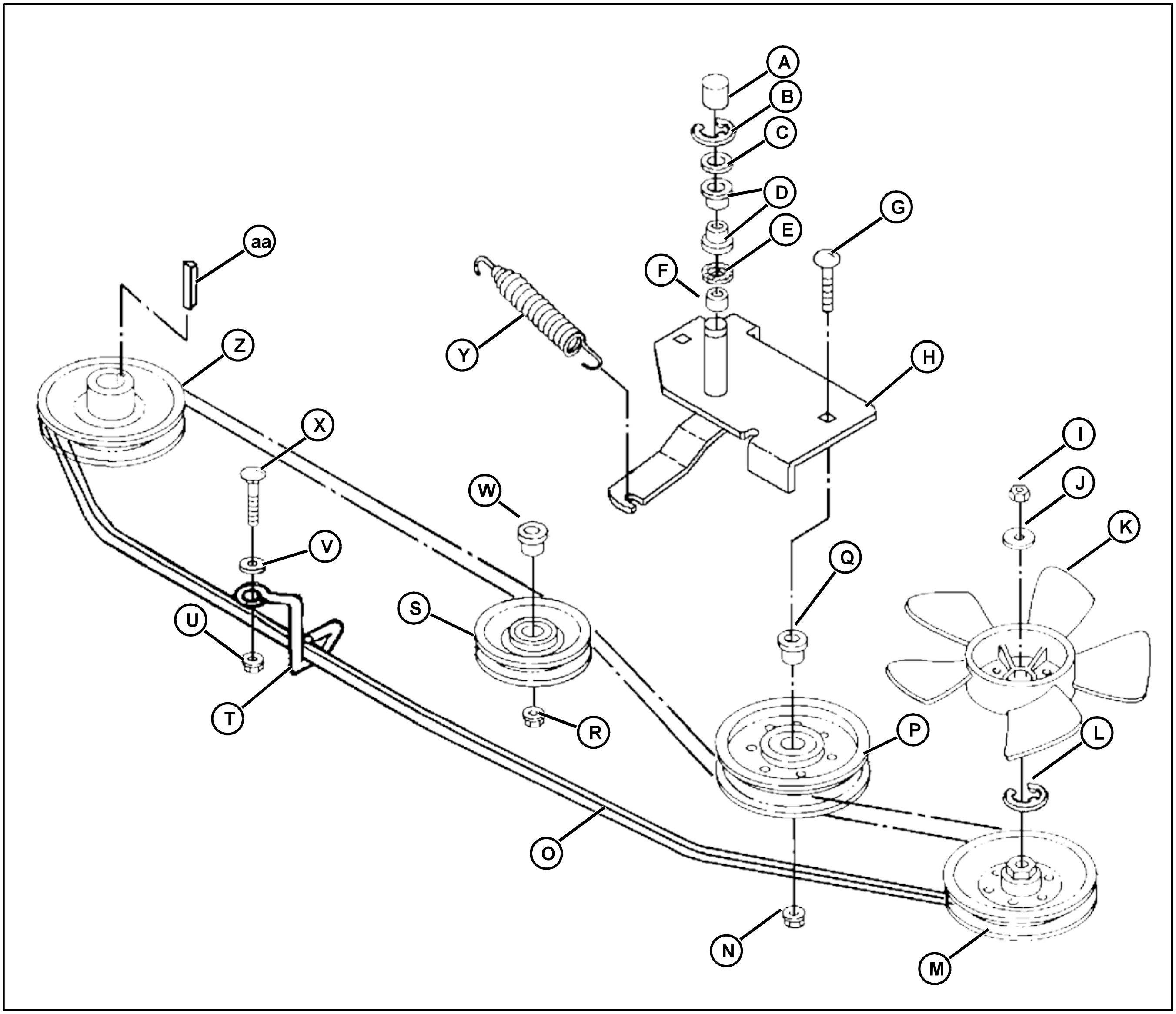
Brake



M99735

A - Spring Pins
B - Arm
C - Cotter Pin
D - Rod
E - Upper Case Housing
F - Brake Shoe
G - Shim
H - Actuator
I - Shaft
J - Snap Ring
K - Washer
L - O-Ring
M - Spring

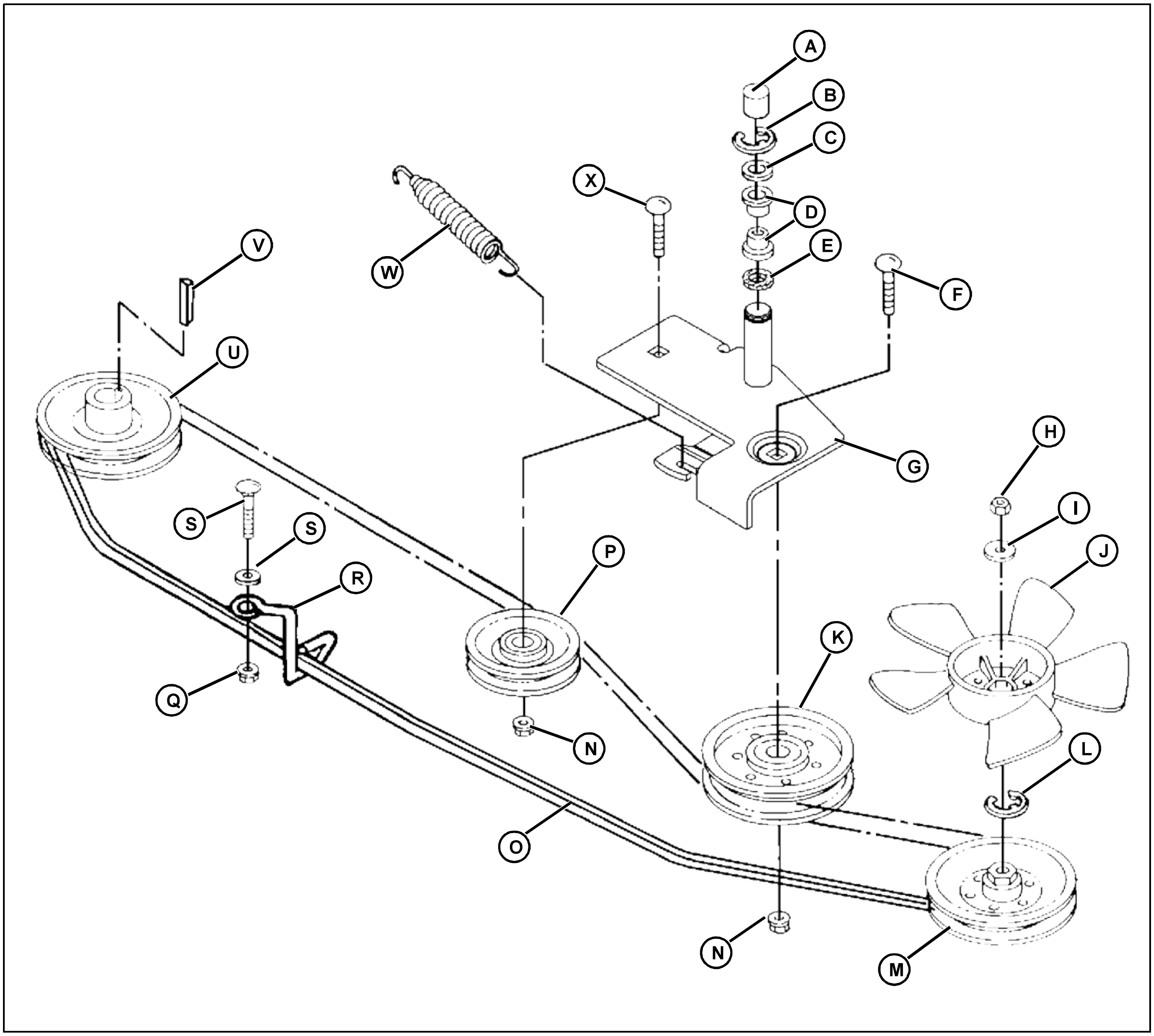
Belt Drive and Idlers - 2WS



M99638

A - Cap
B - E-Clip
C - Washer
D - Bushing
E - Felt Washer
F - Spacer
G - Carriage Bolt
H - Idler Arm
I - Nut
J - Washer
K - Fan
L - E-Clip
M - Driven Sheave
N - Nut
O - Belt
P - Flat Idler
Q - Bushing
R - Nut
S - V-Idler
T - Belt Guide
U - Nut
V - Washer
W - Spacer
X - Carriage Bolt
Y - Spring
Z - Drive Sheave
AA- Key

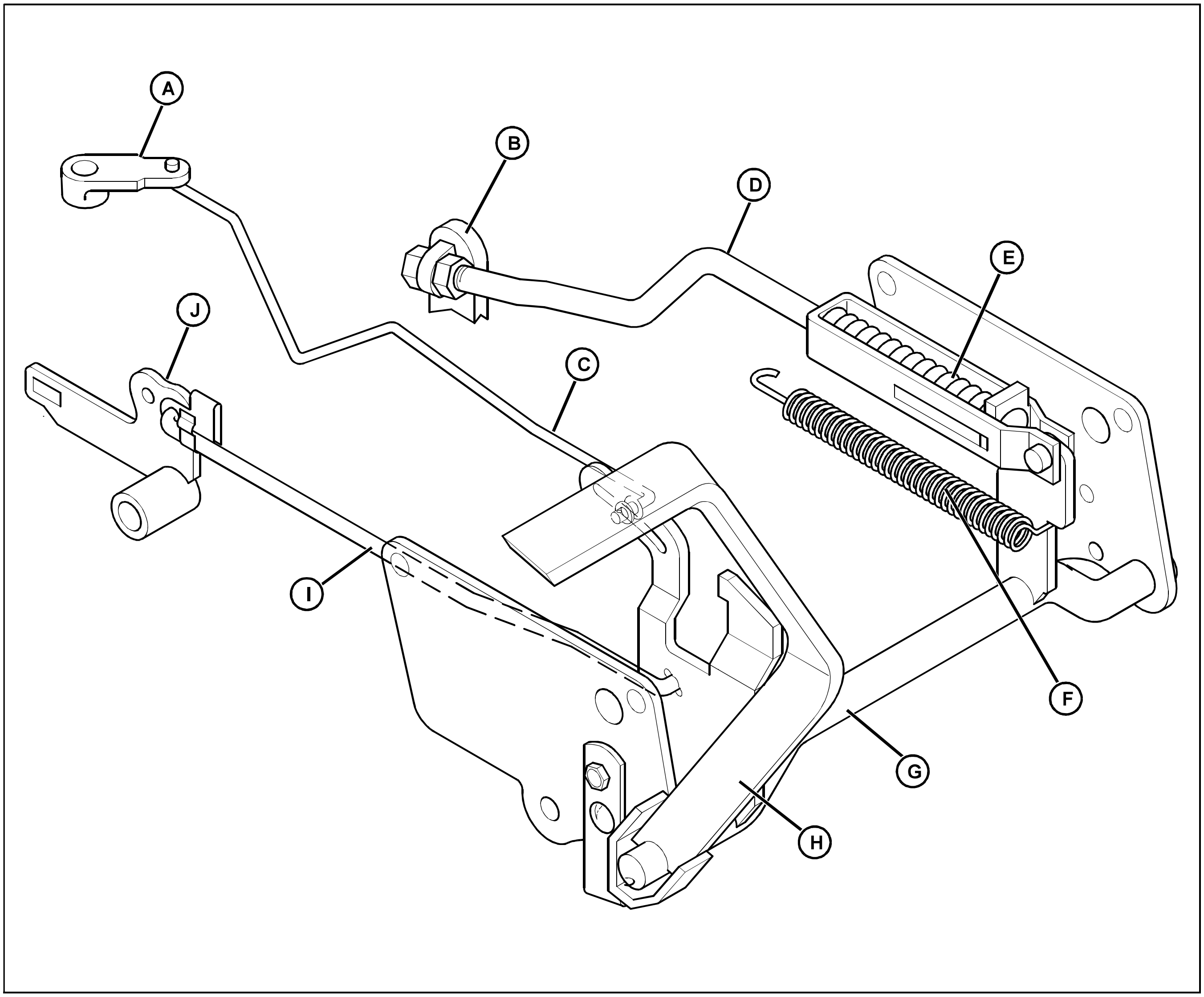
Belt Drive and Idlers - AWS



MX11951

- A - Cap
- B - E-Clip
- C - Washer
- D - Bushing
- E - Felt Washer
- F - Carriage Bolt
- G - Idler Arm
- H - Nut
- I - Washer
- J - Fan
- K - Flat Idler
- L - E-Clip
- M - Driven Sheave
- N - Nut
- O - Belt
- P - V-Idler
- Q - Nut
- R - Belt Guide
- S - Washer
- T - Carriage Bolt
- U - Drive Sheave
- V - Key
- W - Spring
- X - Carriage Bolt

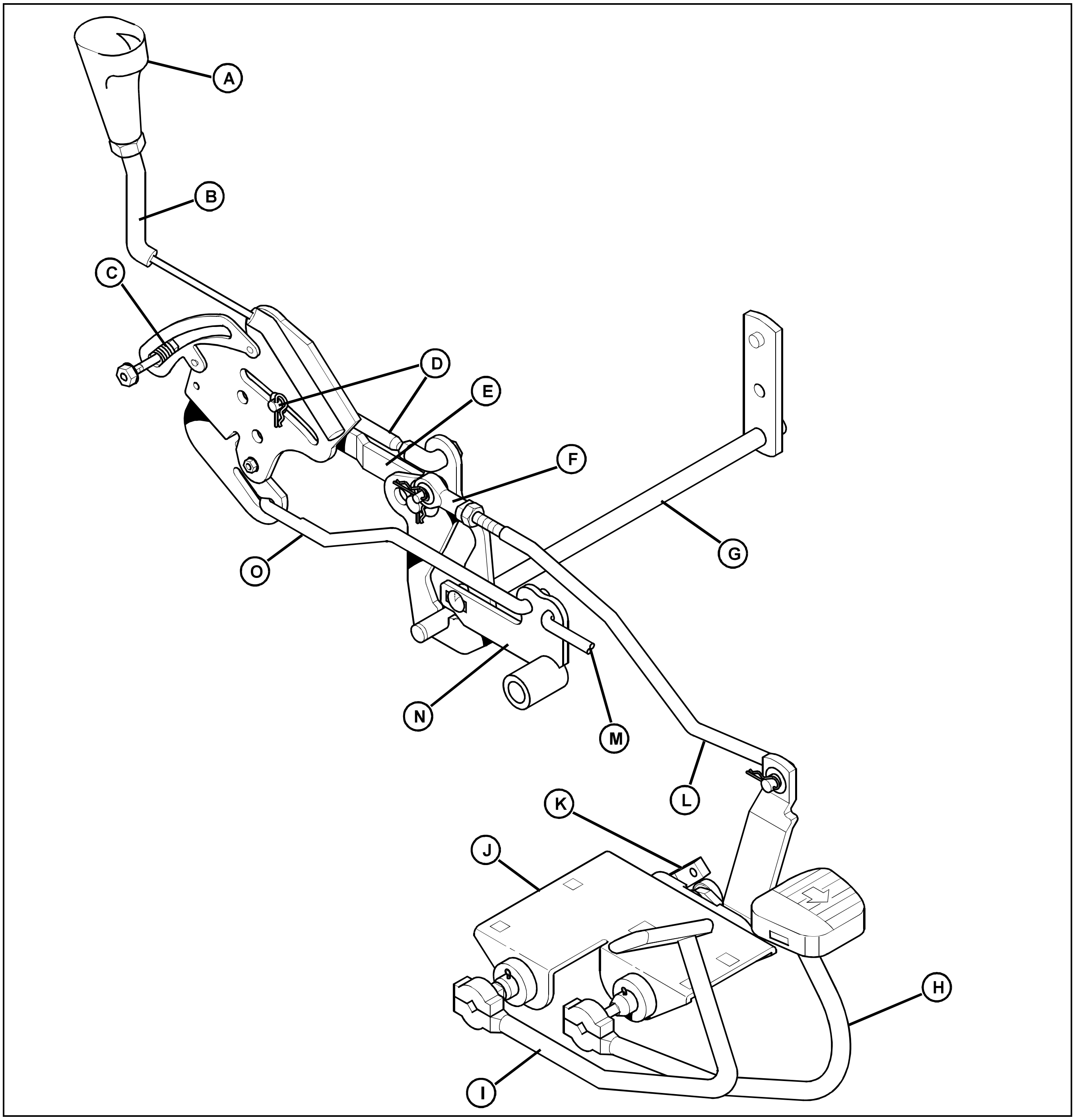
Brake Pedal and Linkage



MIF

A - Freewheeling Arm
B - Brake Arm (On Transmission)
C - Freewheeling Interlock Rod
D - Brake Rod
E - Brake Spring
F - Brake Return Spring
G - Brake Shaft
H - Brake Pedal
I - Neutral Return Rod
J - Neutral Return Arm

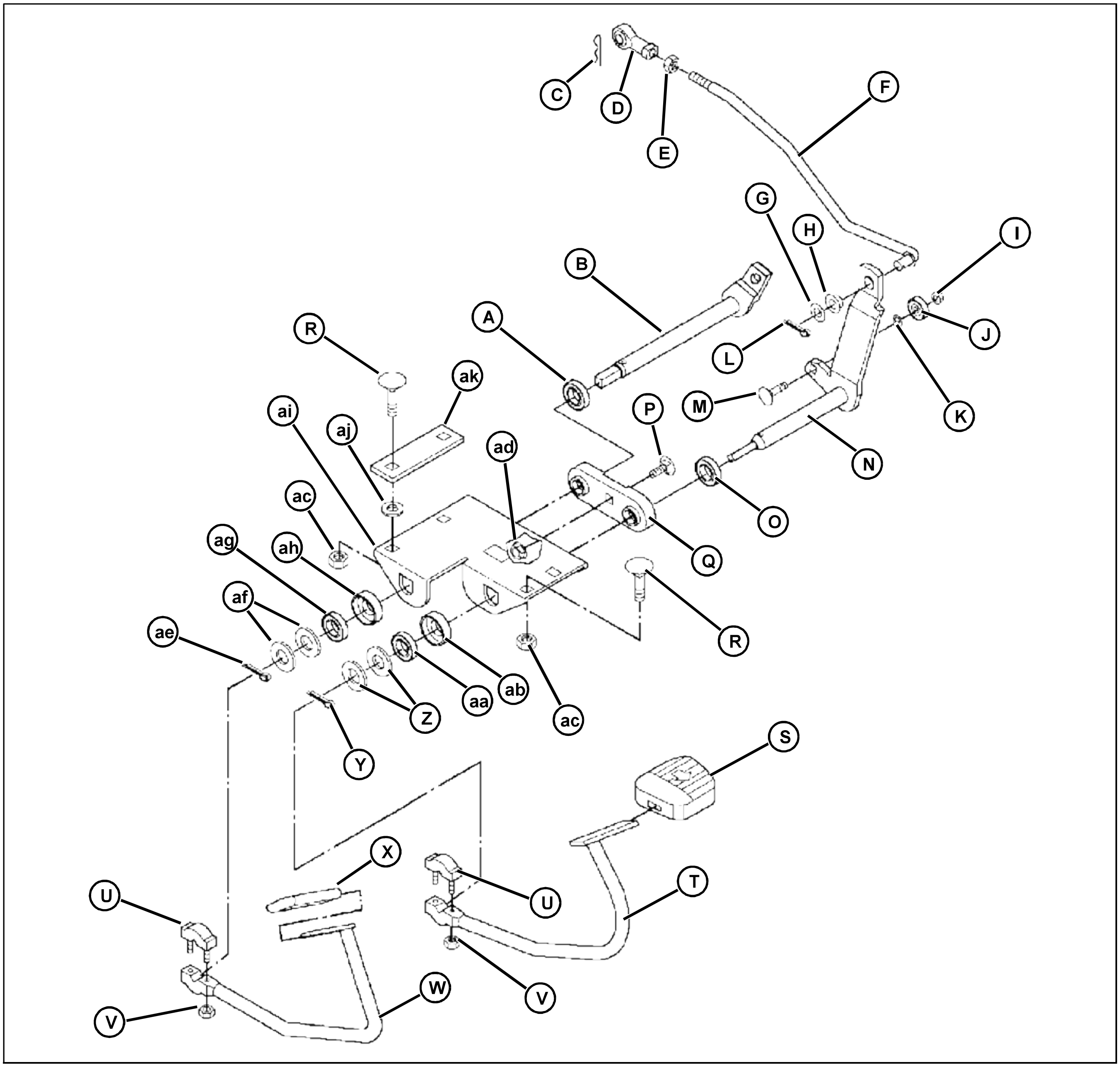
Forward and Reverse/Cruise Control Linkage



- I - Reverse Pedal
- J - Pedal Shafts Bracket
- K - Reverse Shaft
- L - Forward/Reverse Control Rod
- M - Neutral Return Rod
- N - Neutral Return Arm
- O - Cruise Control Interlock Rod

- A - Cruise Control Knob
- B - Cruise Control Lever
- C - Friction Device
- D - Hand Lever Rod
- E - Transaxle Control Rod
- F - Ball Joint
- G - Intermediate Shaft
- H - Forward Pedal

Forward and Reverse Pedals and Linkage (Exploded View)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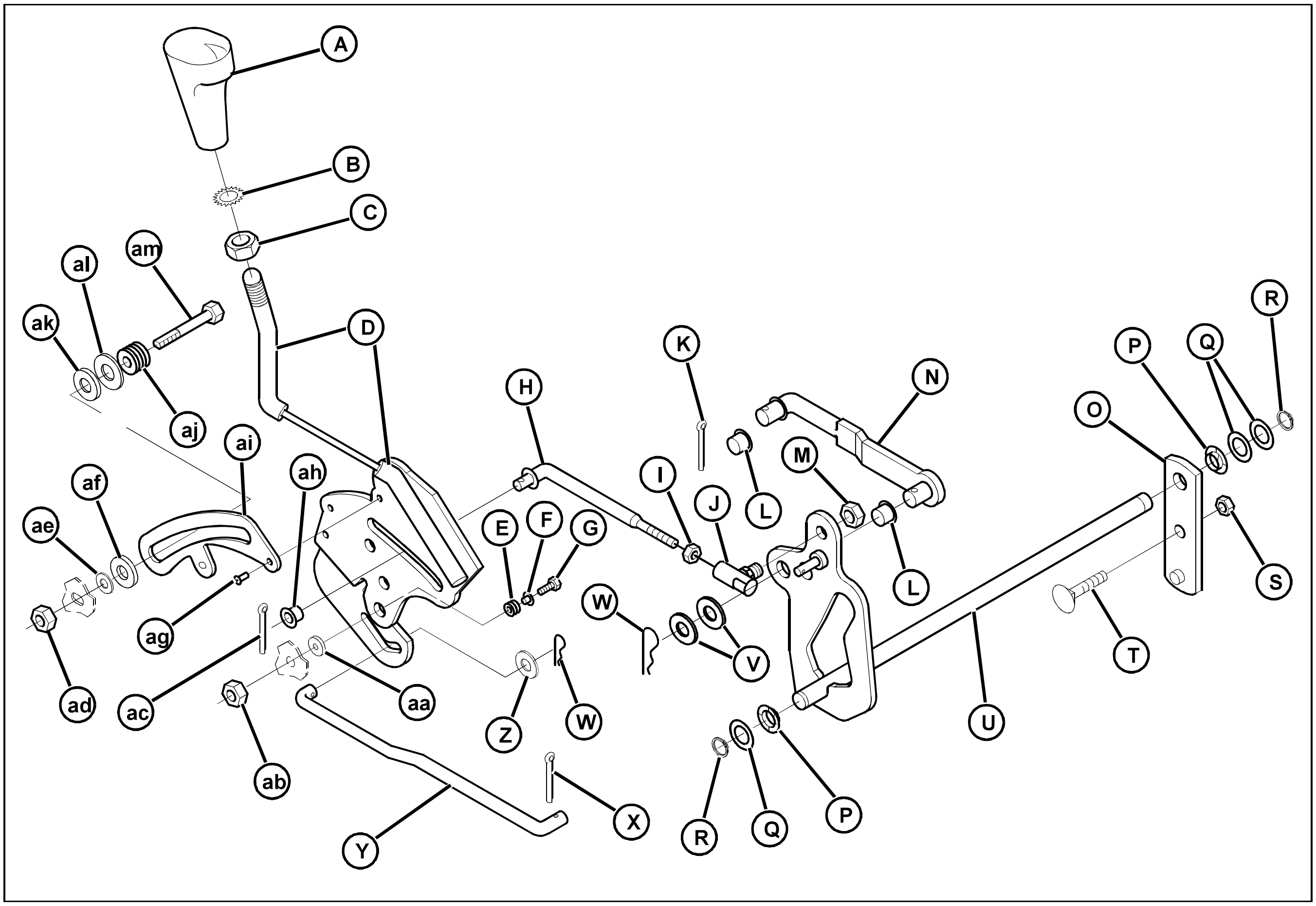
M99584

- **A - Bearing**
- **B - Reverse Control Shaft**
- **C - Spring Locking Pin**
- **D - Ball Joint**
- **E - Nut**
- **F - Forward/Reverse Control Rod**
- **G - Washer**
- **H - Bushing**
- **I - Nut**
- **J - Bearing**
- **K - Washer**
- **L - Cotter Pin**
- **M - Carriage Bolt**
- **N - Forward Control Shaft**
- **O - Bearing**
- **P - Carriage Bolt**
- **Q - Bearing Retainer**
- **R - Carriage Bolt**
- **S - Pedal Pad (Forward)**
- **T - Pedal (Reverse)**
- **U - Clamp**
- **V - Nut**
- **W - Pedal (Reverse)**

X - **Pedal Pad (Reverse)**
Y - **Cotter Pin**
Z - **Washers**
AA- **Bearing**
AB- **Bearing Support**
AC- **Nut**
AD- **Nut**
AE- **Cotter Pin**
AF- **Washers**
AG- **Bearing**
AH- **Bearing Support**
AI - **Bracket**
AJ- **Washers**
AK- **Strap**

Cruise Control Lever and Linkage (Exploded View)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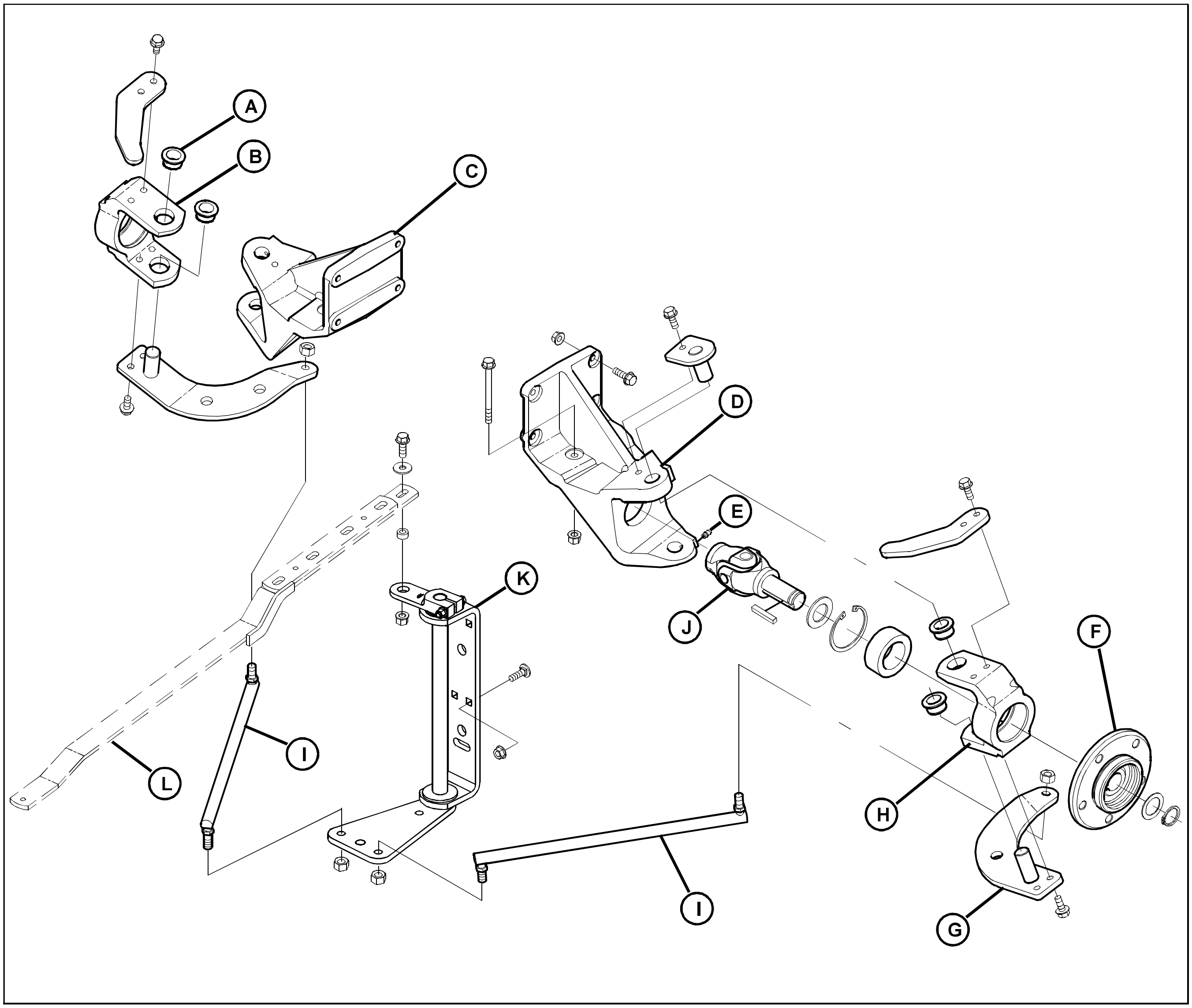
MIF

A - **Knob**
B - **Lock Washer**
C - **Nut**
D - **Lever**
E - **Spring**
F - **Bushing**
G - **Cap Screw**
H - **Rod**
I - **Nut**
J - **Ball Joint**
K - **Cotter Pin**
L - **Bushing**
M - **Nut**
N - **Rod**
O - **Bracket**
P - **Bushing**
Q - **Washer**
R - **Snap Ring**
S - **Nut**
T - **Carriage Bolt**
U - **Shaft**
V - **Washers**
W - **Quick Lock Spring Pin**
X - **Cotter Pin**
Y - **Rod**

Z - Washer
AA- Washer
AB- Nut
AC- Bushing
AD- Nut
AE- Washer
AF- Washer
AG- Rivet
AH- Bushing
AI - Plate
AJ- Disk Spring
AK- Washer
AL- Washer
AM- Bolt

Rear Axle - AWS



MIF

A - Bearing
B - Pivot
C - Rear Axle Support
D - Rear Axle Support
E - Grease Fitting
F - Hub
G - Spindle
H - Pivot
I - Tie Rod
J - Universal Joint
K - Pivot
L - Control Strap

Theory of Operation

Controls and Linkage Operation

Function:

The controls and linkage for the hydrostatic power train provide mechanical means of operating the forward/reverse control lever on the transaxle through the forward (6) and reverse (5) pedals, and a means of maintaining forward speed without holding the forward pedal down when using the cruise control lever. They also engage the transaxle brake, and ensure that the brake is released when the forward or reverse pedals are engaged, and that the forward/reverse controls on the transaxle will return to NEUTRAL when the brake pedal (7) is pressed.

Foot Pedals:

The internal transaxle engagement is controlled by the foot control pedals (forward - reverse - brake) through the control linkage.

The forward and reverse pedals pivot through the pedal shafts bracket and rotate the pedal control arm forward or rearward (reverse). The pedal control arm either pulls or pushes the forward/reverse control rod. In turn, the forward/reverse rod moves (pivots) the intermediate shaft plate (4) forward and rearward.

The transaxle control rod (10) connects the intermediate shaft plate to the transaxle control shaft (11). As the intermediate shaft plate rotates forward, the transaxle is shifted into forward. As the intermediate shaft plate rotates rearward, the transaxle is shifted into reverse.

Cruise Control (Forward Only):

The cruise control system holds the transaxle linkage in a forward position. The hand lever rod connects the cruise control lever to the intermediate shaft plate. When the cruise control is engaged, the hand lever rod is moved forward rotating the intermediate shaft forward. The friction device (1) holds the cruise control lever in the set position.

When the brake pedal is depressed, the cruise control interlock rod is pulled forward, and the cruise control lever (2) is pulled back to a neutral position (3).

Brake Pedal:

The brake functions, through a mechanical linkage, to return the intermediate shaft plate and transaxle, and the cruise control lever to neutral positions.

Hand Control:

An optional hand control may be installed that replaces the forward and reverse pedals.

Foot Control - Neutral Position

Function:

The function of a properly adjusted linkage in a neutral position ensures that the transaxle control shaft is in the neutral position when the forward or reverse pedals are released, or the brake pedal is fully depressed.

NOTE: With the cruise control lever in the OFF position, the hand lever rod moves freely in the cruise control lever slot. The foot pedal controls operate independently from the cruise control lever.

A spring inside the transaxle returns the transaxle control shaft to the neutral position. As the transaxle control shaft rotates to the neutral position, the transaxle control rod moves the intermediate shaft plate to the neutral position, and the forward/reverse rod moves the pedal control arm and pedals to the neutral position.

Depressing the brake pedal pulls the neutral return rod (8) forward, rotating the neutral return arm (9). As the neutral return arm rotates, a bearing attached to the neutral return arm, and riding in the inner cam profile of the intermediate shaft plate moves the intermediate shaft plate to the neutral position. The intermediate shaft plate moves the transaxle control rod and places the transaxle control shaft in the neutral position. See “Brake Depressed - Maximum” on page 378

Foot Control - Forward (Maximum)

Function:

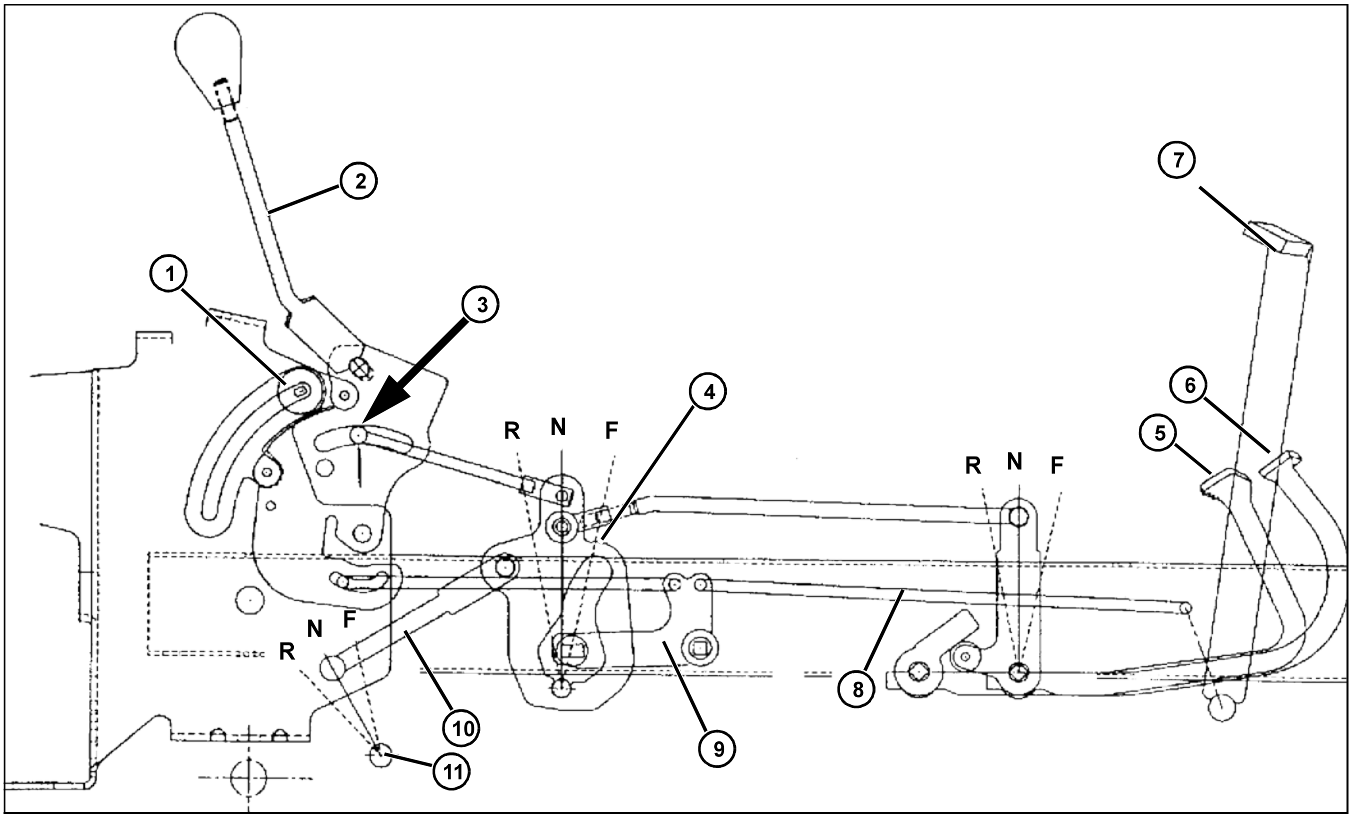
When the forward pedal is depressed, the transaxle control shaft is moved to the forward position and the transaxle engages in forward drive. See “Function:” on page 375

The forward pedal pivots through the pedal shafts bracket and rotates the pedal control arm (13) forward. The pedal control arm pulls the forward/reverse control rod. In turn, the forward/reverse rod pivots the intermediate shaft plate forward.

The transaxle control rod connects the intermediate shaft plate to the transaxle control shaft. As the intermediate shaft plate rotates forward, the transaxle control shaft is shifted into forward.

NOTE: With the cruise control lever in the NEUTRAL position, the hand lever rod moves freely in the cruise control lever slot (12). The forward pedal operates independently from the cruise control lever.

Foot Control - Neutral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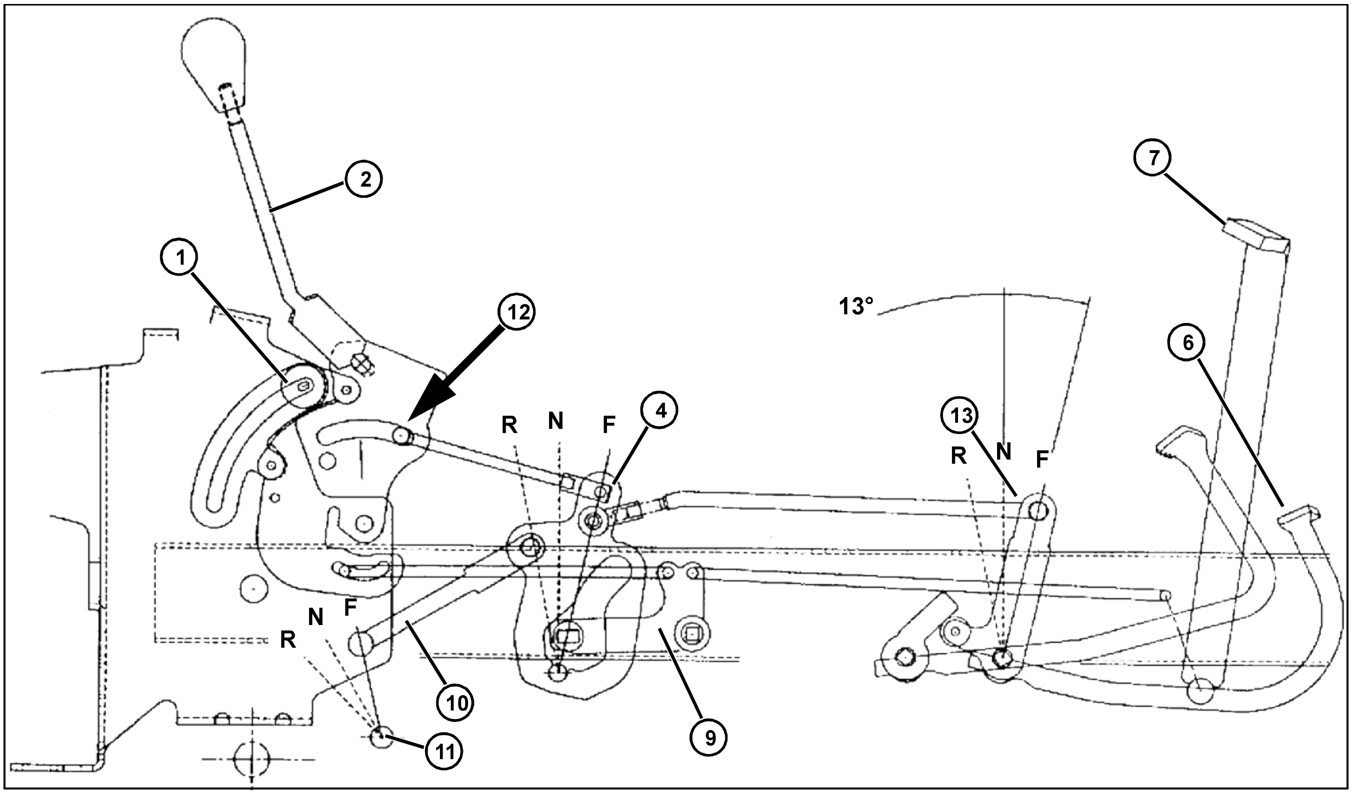
M99597

Foot Control - Forward (Maximum)



M99598

Foot Control - Reverse (Maximum)

Function:

When the reverse pedal (5) is depressed, the transaxle control shaft is moved to the rearward position and the transaxle engages in reverse drive. See “Function:” on page 385.

The reverse pedal has an attached lever that presses down on a bearing on the rear of the pedal control arm (4). When the rear of the pedal control arm is pushed down, the top of the pedal control arm rotates rearward. The pedal control arm pushes the forward/reverse control rod rearward. This, in turn, pivots the intermediate shaft plate rearward.

The transaxle control rod (9) connects the intermediate shaft plate (8) to the transaxle control shaft (10). As the intermediate shaft plate rotates rearward, the transaxle control shaft is shifted into reverse.

NOTE: With the cruise control lever (2, maximum forward (11)) in the NEUTRAL position, the hand lever rod moves freely in the cruise control lever slot. The friction device (1) holds the cruise control lever in the set position. The forward pedal operates independently (3) from the cruise control lever.

Brake Depressed - Maximum

Function:

When the brake pedal (6, maximum (15)) is depressed, the brake neutral return rod (16) is pulled forward. The brake neutral return rod rotates the neutral return arm (7).

When the neutral arm rotates, the attached cruise control interlock rod is pulled forward, rotating the cruise control lever to the OFF position. Note: On machines equipped with the optional hand control (13), the cruise control interlock rod (17) is removed.

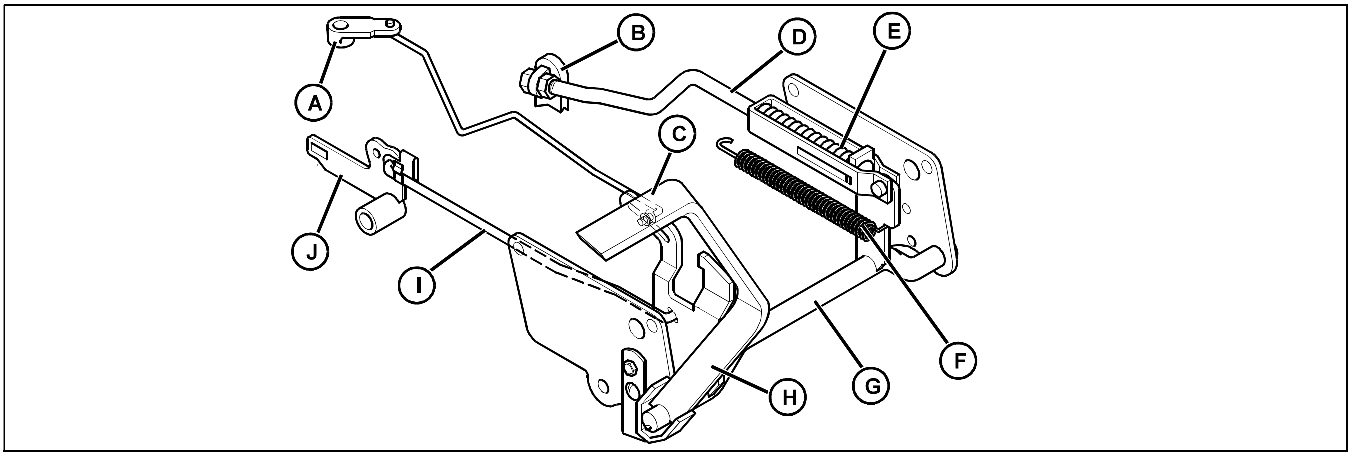
Simultaneously, a ball bearing (attached to rear of the neutral return arm) travels upward along the inner cam profile of the intermediate shaft plate (8). As the ball bearing raises in the inner cam, the intermediate shaft plate is moved into the neutral position (14).

Moving the intermediate shaft plate to the neutral position moves the transaxle control rod and control shaft to the neutral position (12).

The brake rod rotates the transaxle brake arm forward, and the transaxle internal wet brake pads stop the machine. See “Transaxle Brake” on page 388.

If the transaxle is left in the freewheeling mode (freewheeling rod pulled out), the freewheeling interlock rod (see below) is pulled forward when the brake pedal is depressed and the transaxle is shifted out of the freewheeling mode. Forcing the transaxle out of the freewheeling mode prevents the operator from starting the engine and trying to drive the machine with the transaxle in the freewheeling mode. See “Cranking Circuit Operation” on page 277 in the Electrical section.

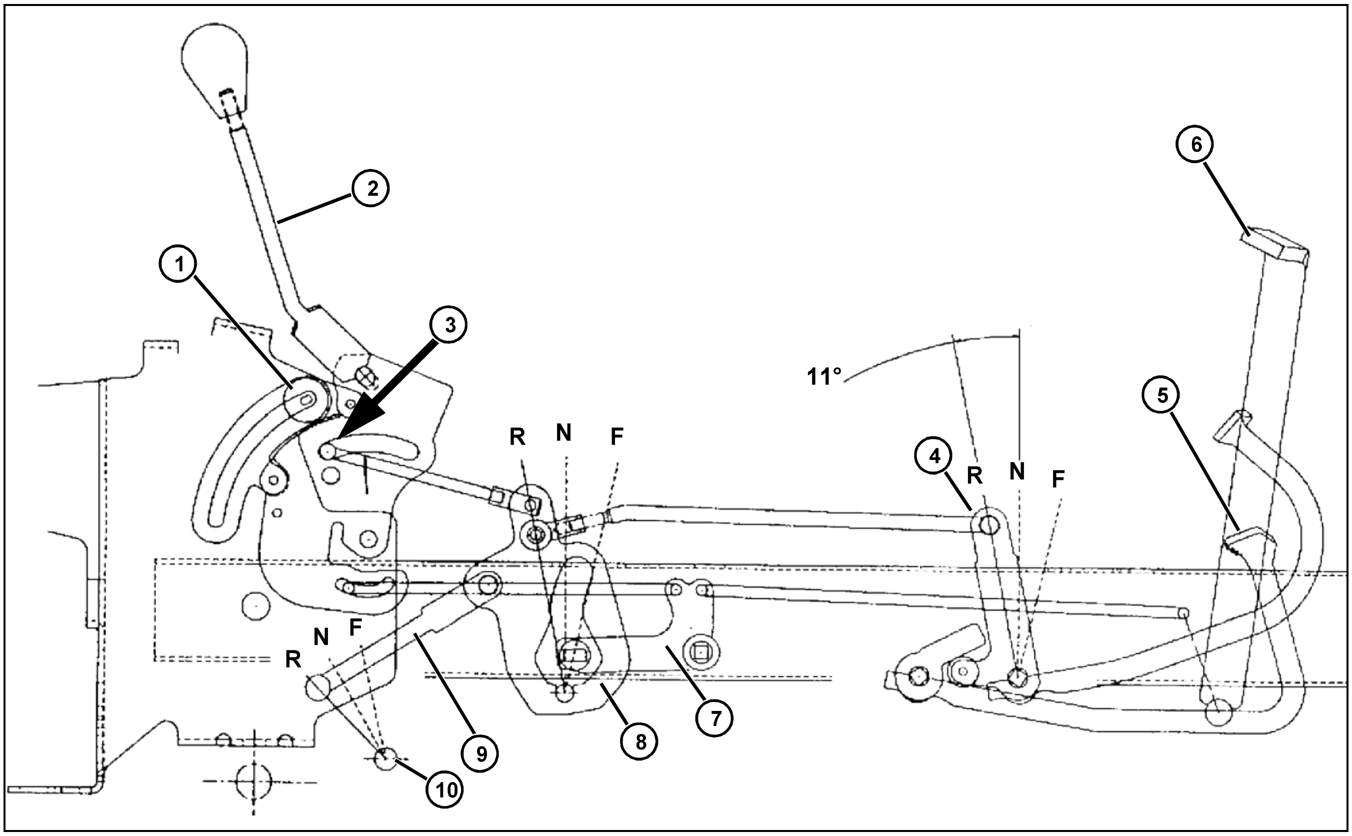
Brake Linkage



MIF

A - Freewheeling Arm
B - Brake Arm (On Transmission)
C - Freewheeling Interlock Rod
D - Brake Rod
E - Brake Spring
F - Brake Return Spring
G - Brake Shaft
H - Brake Pedal
I - Neutral Return Rod
J - Neutral Return Arm

Foot Control - Reverse (Maximum)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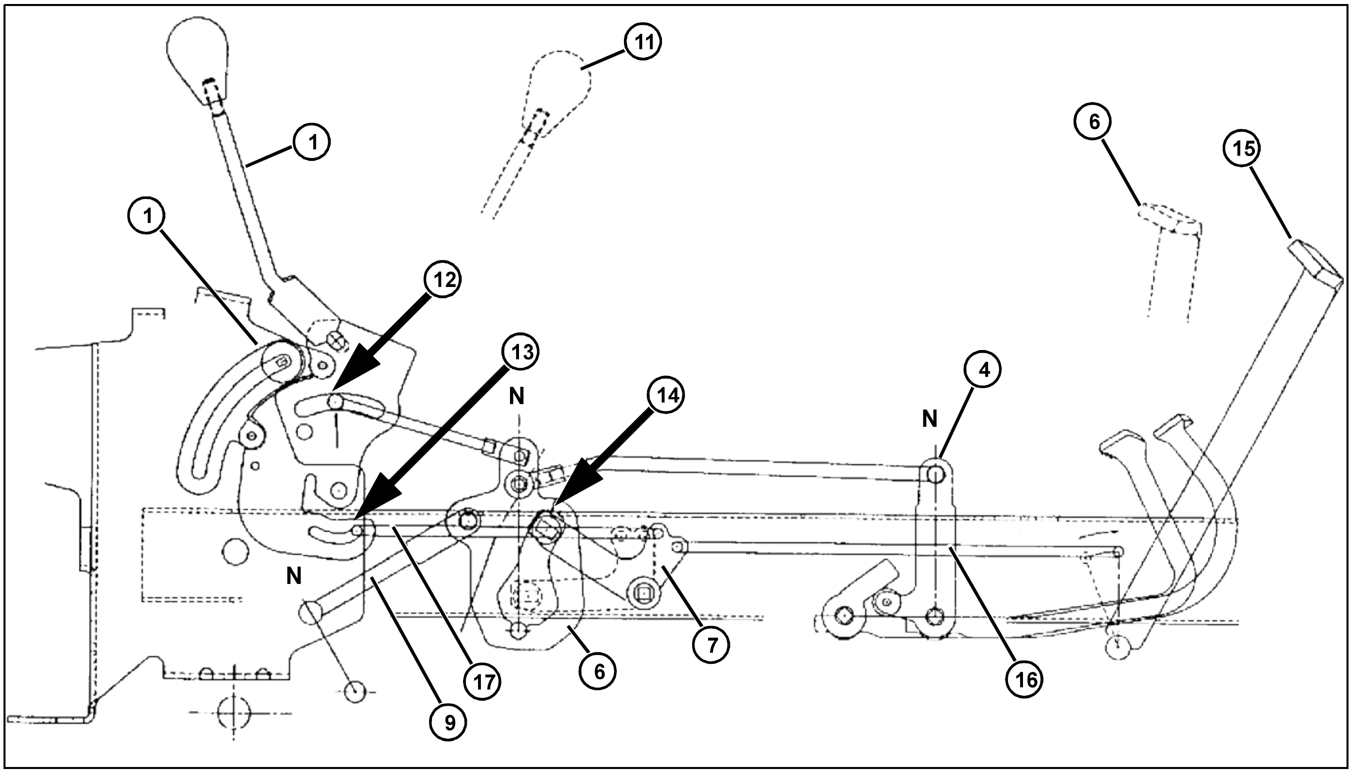
Brake Depressed - Maximum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M99602

Cruise Control

Operation:

Use cruise control to maintain travel speed without having to hold the forward travel pedal down.

NOTE: Cruise control operates only for forward travel.

IMPORTANT: Avoid damage! When cruise control is not in use, hand lever should be returned manually to the OFF position. Otherwise, hand lever will restrict travel of reverse pedal linkage, and reverse speed of machine will be too slow.

Cruise control may be set by moving the cruise control lever (2, maximum forward (12)) forward until the ground speed of the machine is set; or, the forward travel pedal (6) may be depressed to attain the ground speed desired and then maintained by moving the cruise control lever forward.

Depressing the brake pedal (7) will return the cruise control lever to the OFF position. The brake neutral return rod rotates the neutral return arm (8). (The reverse pedal (5) has an attached lever that presses down on a bearing on the rear of the pedal control arm (4).)

Function:

As the cruise control lever is moved forward it pivots and the rear of the hand lever rod (13) slides rearward in the slot (3) in the cruise control lever. When the hand rod lever reaches the rear of the slot, and the cruise control lever is moved farther forward, the hand lever rod is pushed forward.

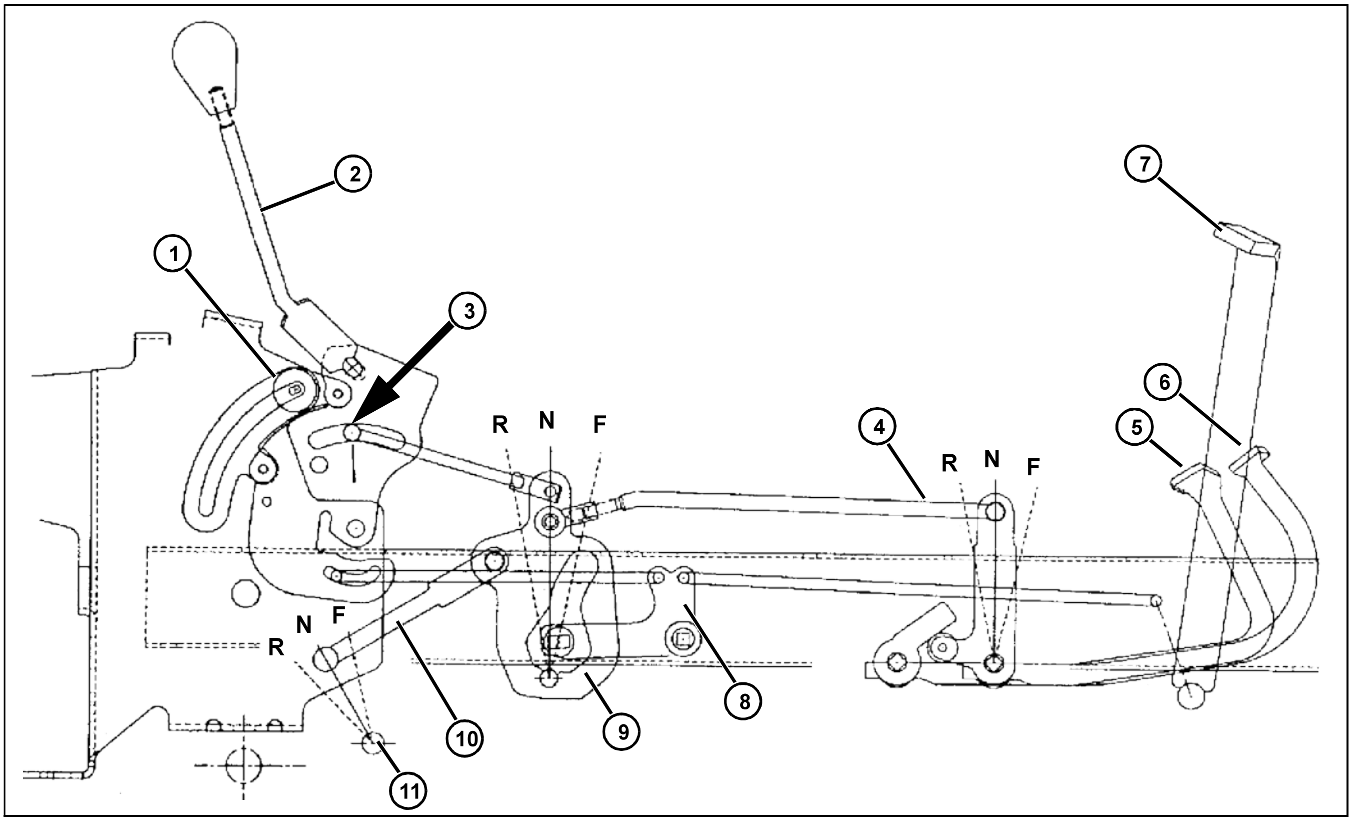
The hand lever rod pushes the top of the intermediate shaft plate (9) forward and pivots the plate forward.

The transaxle control rod (10) connects the intermediate shaft plate to the transaxle control shaft (11). As the intermediate shaft plate rotates forward, the transaxle control shaft is shifted into forward.

The friction device (1) holds the cruise control lever in position.

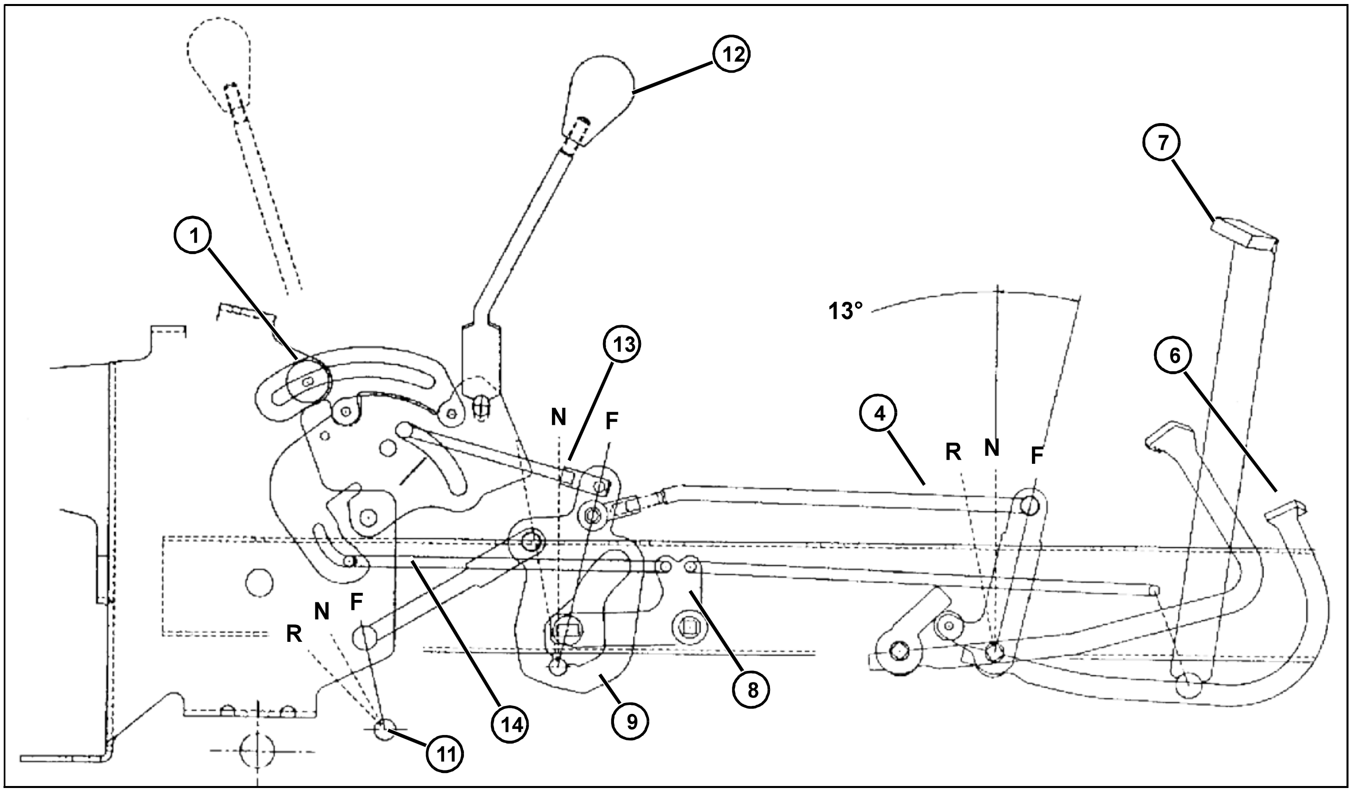
When the brake pedal is depressed, the cruise control interlock rod (14) is pulled forward, and the cruise control lever pivots to the neutral position.

Cruise Control - Off Position



M99600

Cruise Control - Maximum Speed Position



M99601

Hand Control

Function:

The hand control is an option. When installed, the hand control replaces the forward and reverse foot pedal controls.

IMPORTANT: Avoid damage! When the machine is converted from foot control to hand control, the cruise control interlock rod between the intermediate shaft plate and the bottom of the hand lever plate must be removed.
Otherwise, the return to neutral ball bearing will try to return lever to neutral location, but cruise control interlock rod will try to return hand lever all the way rearward to reverse position. Linkage will bind up and damage could result to linkage and transaxle controls.

The hand lever rod (4) (Note position of hand lever rod end (3)) provides a link between the hand lever plate and the intermediate shaft plate (7).

When the hand control is moved to a forward position (10), the hand lever plate rotates forward and the hand lever rod pushes the top of the intermediate shaft plate forward.

Hand Control - Neutral

The transaxle control rod (8) connects the intermediate shaft plate to the transaxle control shaft (9). As the intermediate shaft plate rotates forward, the transaxle control shaft is shifted into forward.

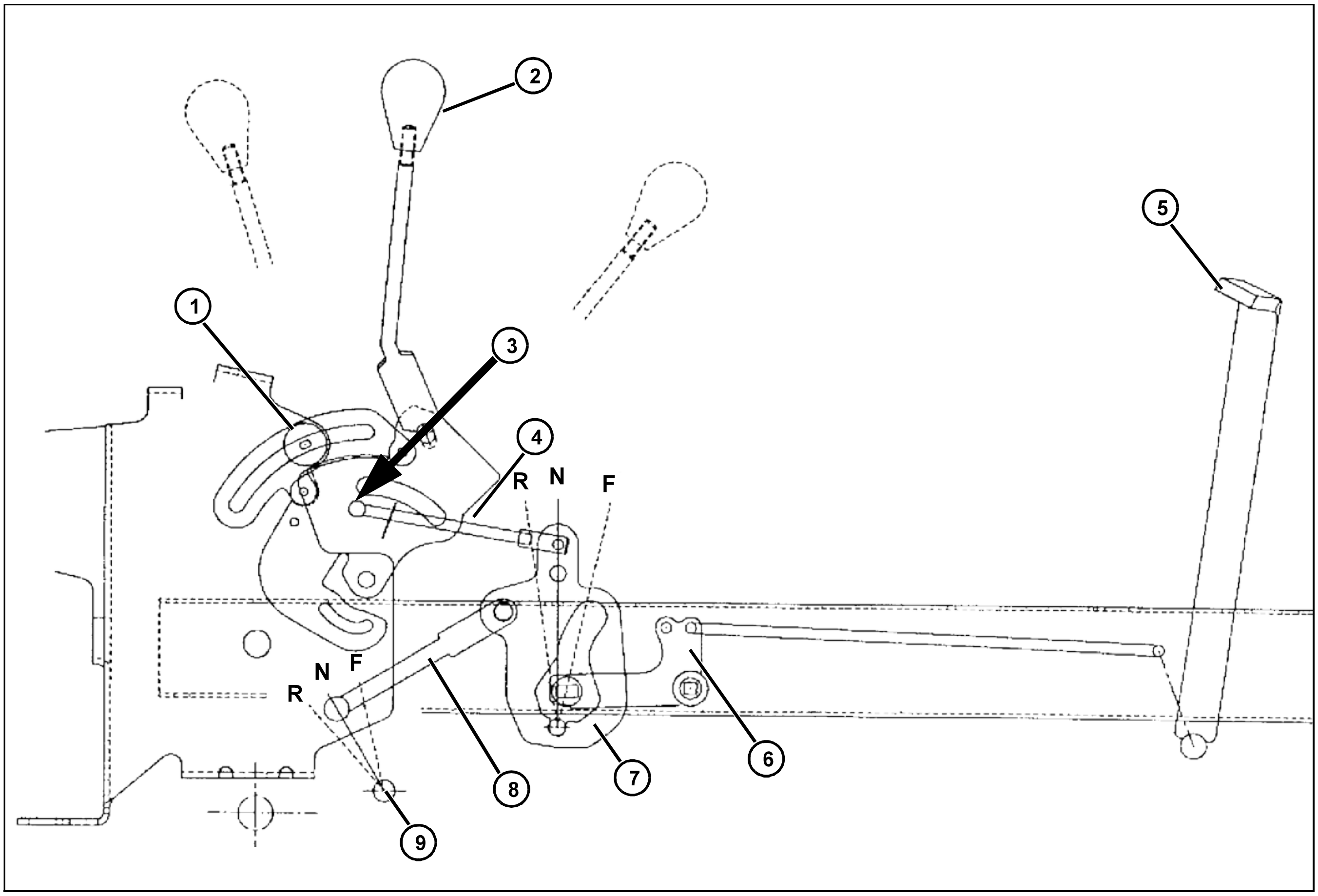
The friction device (1) holds the hand control lever in position.

When the brake pedal (5) is depressed, the brake neutral return rod is pulled forward. The brake neutral return rod rotates the neutral return arm (6).

When the neutral return arm rotates, the ball bearing forces the intermediate shaft plate back to neutral. The attached hand lever rod is pushed backward, rotating the hand control lever to the neutral position (2).

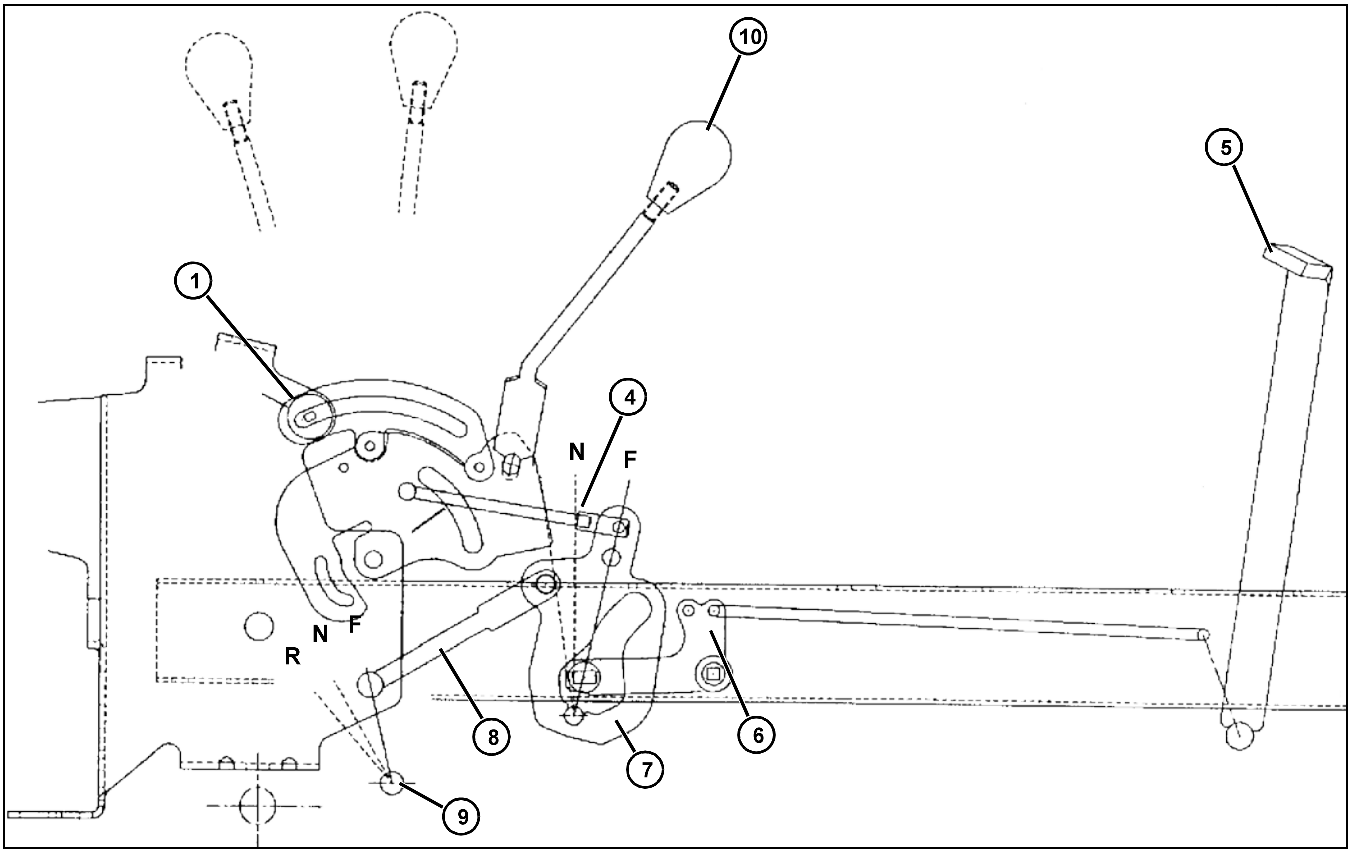
When the hand control is moved to a reverse position (11), the hand lever plate rotates rearward and the hand lever rod pulls the top of the intermediate shaft plate rearward.

As the intermediate shaft plate rotates rearward, the transaxle control shaft is shifted into reverse.



M99603

Hand Control - Forward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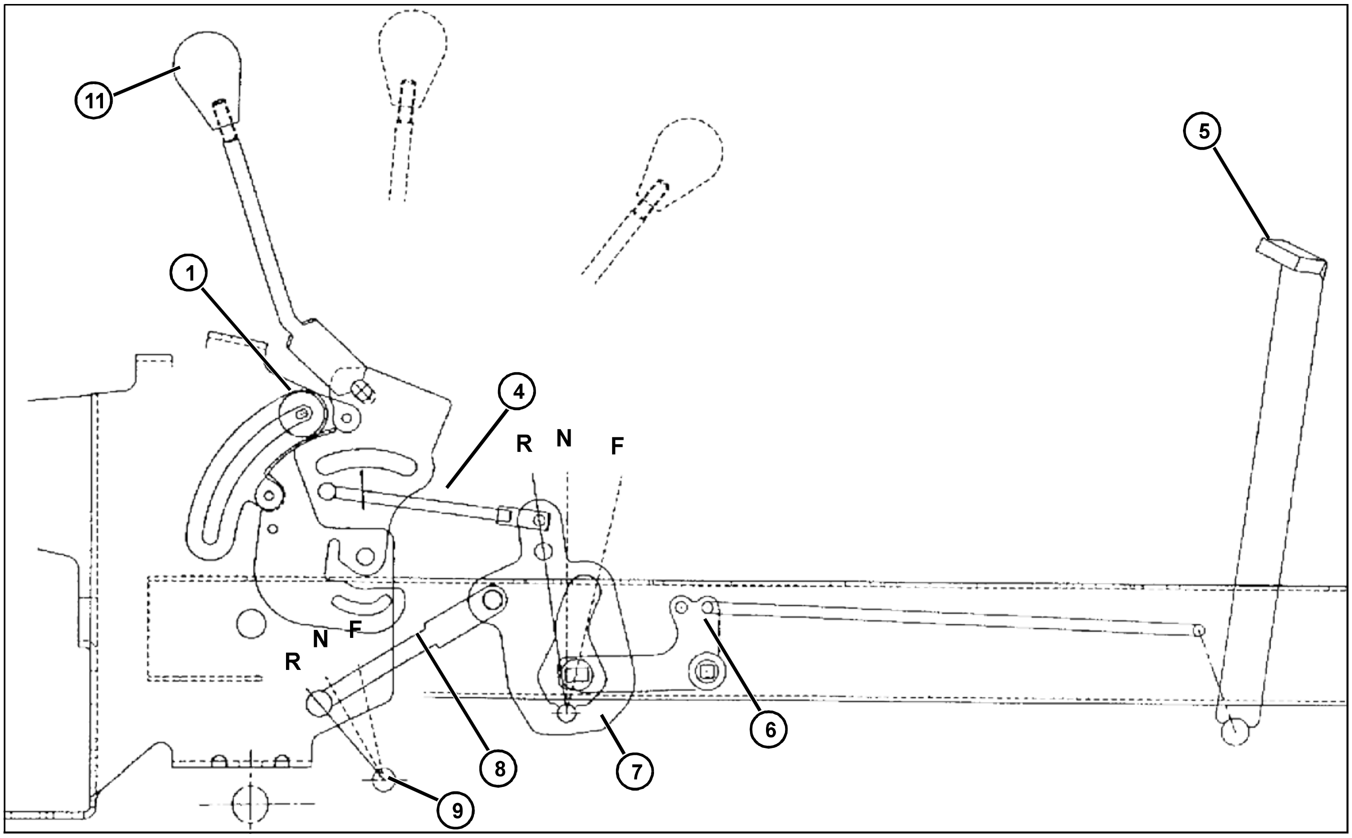
M99604

Hand Control - Reverse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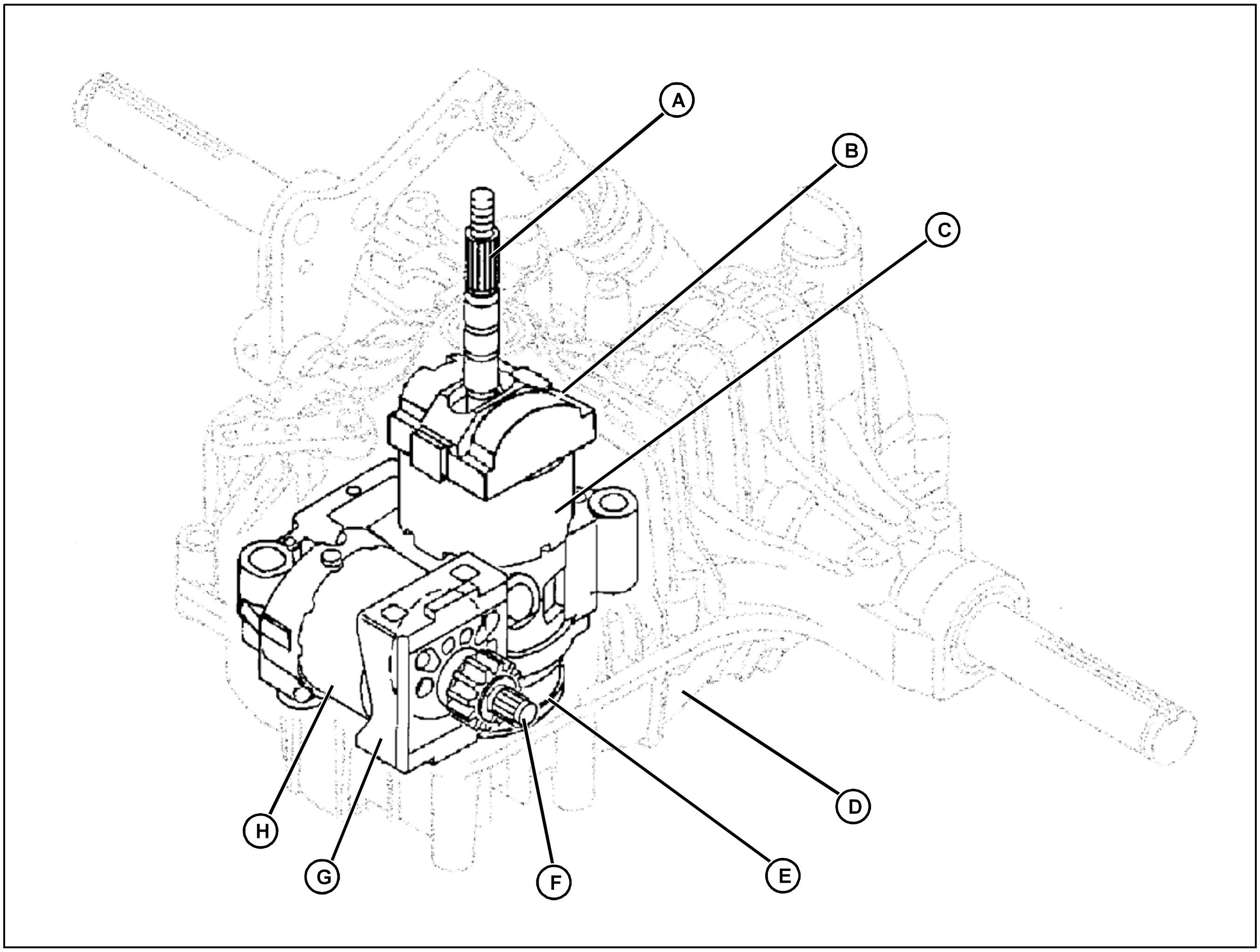
M99605

Hydrostatic System Operation



M95065

Function:

The hydrostatic transaxle provides a means of transferring power from the input sheave to the axle shafts of the transaxle. It also provides infinitely variable speed control and the capability of forward or reverse directional travel of the machine.

Theory of Operation:

As the input sheave is rotated by the traction drive belt it rotates the pump input shaft (A). The pump input shaft is splined to the pump rotating group (H) and the charge pump. The pump rotating group is composed of an axial piston pump and a variable displacement swash plate (B). The charge pump is composed of a Gerotor pump that draws pressure-free oil from the reservoir (D) through the filter (E) and supplies oil to the pump rotating group. The pump rotating group provides oil under pressure to the motor rotating group (C). The motor rotating group is composed of an axial piston motor with a fixed position swash plate (G), and converts hydraulic energy into rotary motion, which is output through the motor output shaft (F). This rotary motion of the motor output shaft is the beginning of the gear power flow.

Neutral:

With the transmission in the neutral position, the swash plate is held perpendicular to the piston. Springs in the pump cylinder block force the pump pistons against the swash plate. Since the variable displacement swash plate is perpendicular to the axis of the pistons, there is no reciprocating motion of the pistons in the cylinders, and no oil is displaced. Because there is no demand for oil in the pump, both directional check valves are closed, and the machine remains stationary.

Forward:

As the direction control arm is moved to the forward position, the variable displacement swash plate is rotated from its neutral position.

Springs inside the pistons force them against the swash plate. As the swash plate angle increases, the pistons are forced in and out of the pump body as the piston block turns, displacing oil. As the pistons rotate, they follow the angled swash plate, and move outward in their bores, drawing in oil. As the pistons continue to rotate, the swash plate angle forces the pistons back into their bores, and oil is displaced through ports in the valve body.

Pressurized oil from the pump forces the forward check valve closed and supplies high pressure oil to the motor rotating group.

The rotating group of the motor presses against a fixed angle swash plate. Oil enters the piston bore through a port in the valve body at a point where the piston is compressed in its bore.

As the oil fills the piston bore, the piston is forced out and follows the angle created by fixed swash plate. This causes the motor rotating group to rotate. The motor rotating group is splined to the output shaft. Oil pressure within these components is directly proportional to the load encountered. This is known as the high pressure side.

The piston continues to be forced out of its bore and follows the fixed angle swash plate until it is no longer aligned with the delivery port of the valve body. Since oil is no longer being displaced to the piston, it no longer adds to the rotary motion of the motor. But, since the pistons next in line to it are now filling with oil, the rotary motion is continued.

As the motor continues to rotate, the pistons pass from the high pressure port to the low pressure port and, as the pistons are forced back into their bores by the angle of the swash plate, oil is forced from the piston bores through the valve body and back to the inlet port of the pump. This is known as the low pressure side.

The oil path from the pump to the motor is known as the high pressure side, because oil pressure increases, depending on the system load. The oil path from the motor back to the pump is known as the low pressure side. From forward drive to reverse drive these two paths switch, which gives opposite rotation to the motor.

A certain amount of oil is lost from the pump and motor rotating groups. This is due to normal leakage, or may be caused by component wear. Since the pump/motor operate in a closed loop system, oil lost from the system must be replenished. Any additional oil required by the system is drawn from the sump, through the filter, by the charge pump. The charge pump keeps a constant pressure and volume of oil supplied to the piston pump. Charge pressure is controlled by the spring holding the charge pump housing on the valve body.

Reverse:

The operation in reverse is the same as in forward. The only difference being that the variable displacement swash plate is rotated in the opposite direction, thus causing oil flow through the valve body in the opposite direction. This causes the reverse check valve to close and supply high pressure oil to the opposite side of the motor rotating group. This causes the output shaft to rotate in the opposite direction, and results in reverse travel of the machine.

When in reverse, the reverse check valve is closed due to high pressure oil forcing it against the seat. The forward check valve will open to sump.

Gear Power Flow

Function:

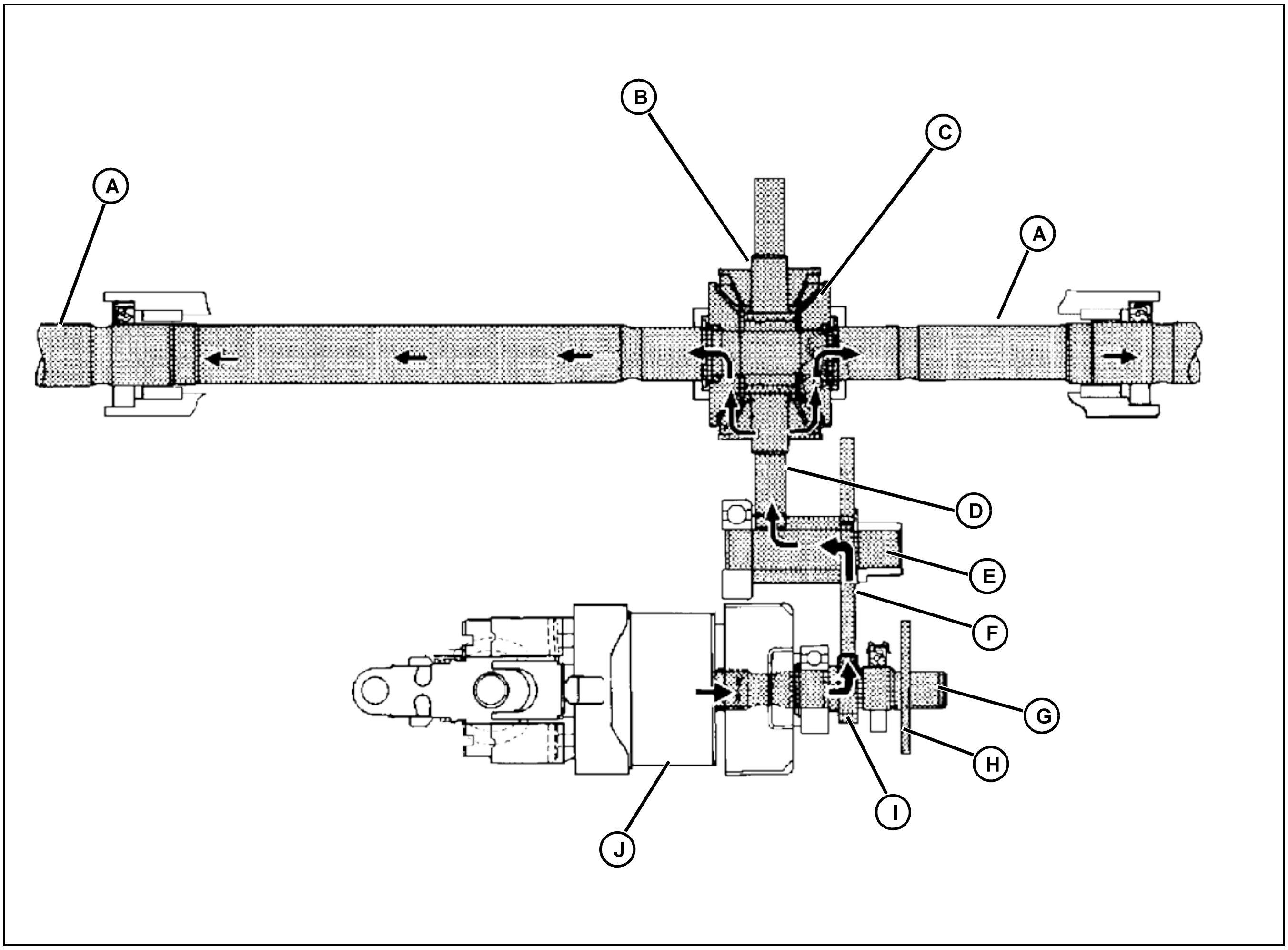
The gear components transfer power from the hydrostatic transaxle components of the transaxle, out the drive axles and to the drive wheels. They also provide a means of making turns with differential action for smooth operation.

Theory of Operation:

The output shaft (G) and output shaft gear (I) are splined to the hydrostatic motor (J). Power from the motor is transferred to the shaft. The output shaft gear meshes with the reduction gear (F) which drives the reduction shaft (E). The reduction shaft drives the differential ring gear (D). Power is transferred from the ring gear to the differential pinion shaft and differential pinion gears (B). The differential bevel gears (C) are splined to the axle shafts (A) and transfer power directly out to the drive wheels.

Splined to the end of the motor output shaft is the brake disc of the brake assembly. The brake is an internal wet disk brake.

When the brake is applied, a lever operated cam presses a brake shoe against the brake disk (H).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M95062

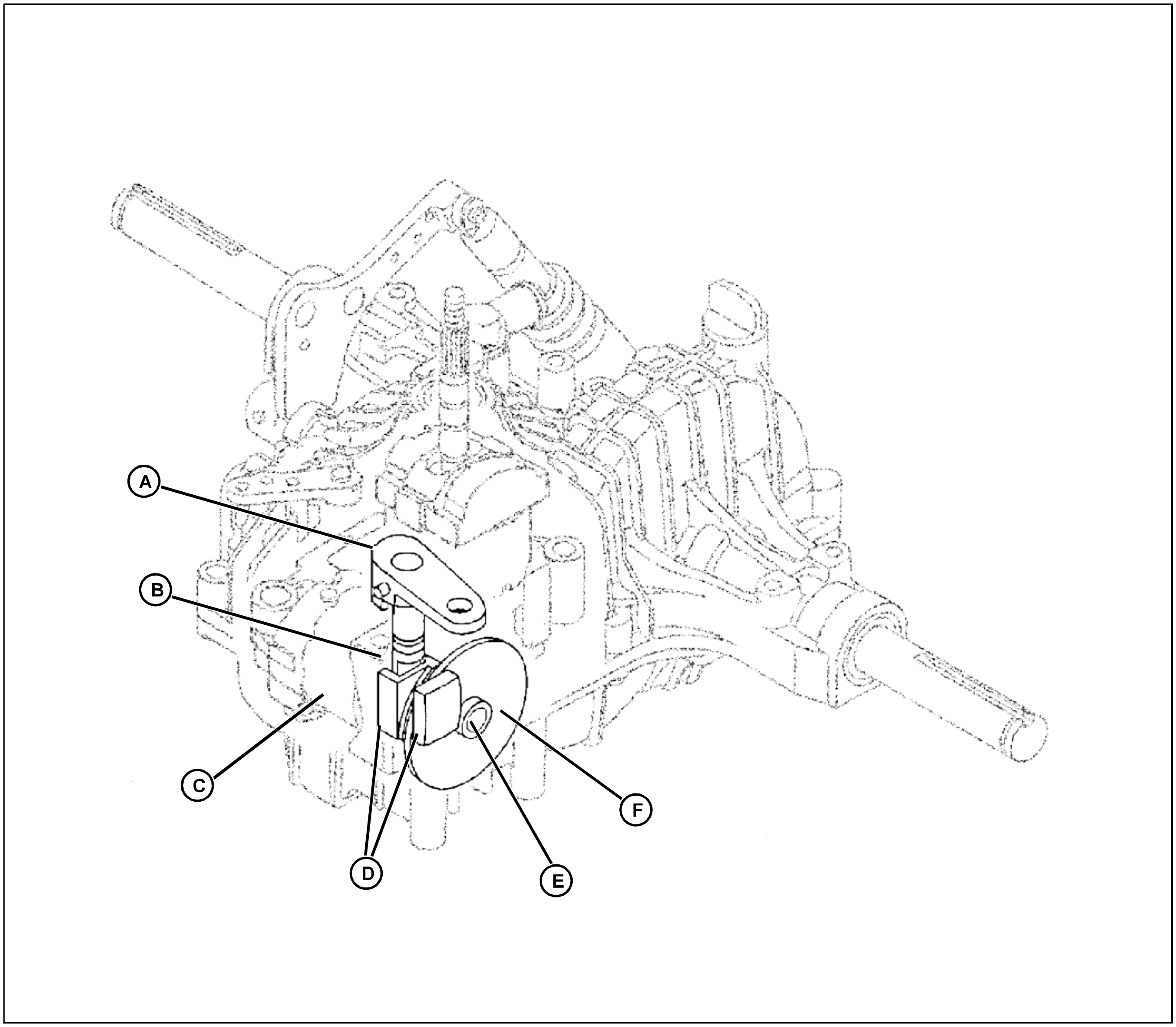
Transaxle Brake

NOTE: K62A transaxle shown below. K62B arm (A) rotated 180°.

The transaxle brake is an internal wet disk brake. When the brake pedal is depressed or the parking brake is set, the brake linkage rotates the brake arm (A).

The brake arm rotates the brake shaft and the brake shaft, acting as a cam (B), presses the brake shoes (D) against the brake disk (F).

The brake disk is splined to the hydrostatic motor (C) output shaft (E).



M95066

Diagnostics

Machine Will Not Move Forward or Reverse

Test Conditions:

- Machine parked on level surface.
- Key switch in STOP position.
- Park brake UNLOCKED.
- Transaxle in NEUTRAL.

NOTE: Steps 15 through 22 require removal of transaxle from machine.

Symptom: Machine Will Not Move Forward or Reverse

(1) Hydrostatic transaxle oil to full mark?

Yes - Go to next step.

No - Fill reservoir to correct level with specified oil.

(2) Is the park brake set?

Yes - Release park brake.

No - Go to next step.

(3) Is the freewheeling lever disengaged?

Yes - Go to next step.

No - Disengage freewheeling lever.

(4) Is the traction belt worn, frayed, glazed or stretched?

Yes - Replace traction belt. See “Traction Drive Belt Removal and Installation” on page 439.

No - Go to next step.

(5) Is the traction belt properly tensioned?

Yes - Go to next step.

No - Check belt tensioning. See “Traction Drive Belt Tensioner Assembly” on page 442.

(6) Is the brake linkage properly adjusted?

Yes - Go to next step.

No - Adjust brake linkage. See “Brake Linkage Adjustment” on page 410.

(7) Are the brake rod and lever damaged or binding?

Yes - Eliminate binding, replace damaged components.

No - Go to next step.

Symptom: Machine Will Not Move Forward or Reverse

(8) Does the forward/reverse pedal linkage move freely?

Yes - Go to next step.

No - Eliminate binding, replace faulty or damaged components. See “Control Pedals and Linkage” on page 443.

(9) Are the control arm and spring pin intact and present?

Yes - Go to next step.

No - Replace control arm and/or spring pin.

(10) Is the shock absorber binding or damaged?

Yes - Replace shock absorber.

No - Go to next step.

(11) Are the engine and transaxle drive sheaves intact, and are the keys or keyways damaged?

Yes - Replace sheaves or keys.

No - Go to next step.

(12) Is the cruise control linkage binding or damaged?

Yes - Eliminate binding, replace faulty or damaged components.

(13) Idler arm assembly pivots freely, no wear in bearing?

Yes - Go to next step.

No - Lubricate and/or replace assembly.

(14) Belt idler assembly tension spring maintains tension on belt?

Yes - Go to next step.

No - Replace tensioning spring.

(15) Hydrostatic oil filter is free of debris, not plugged?

Yes - Go to next step.

No - Replace filter.

(16) Freewheel linkage components move freely and are not damaged?

Yes - Go to next step.

No - Eliminate binding and/or replace damaged components. See “Transaxle Disassembly” on page 423.

Symptom: Machine Will Not Move Forward or Reverse

(17) Input pump shaft splines are not worm or damaged, positively engaged in pump?

Yes - Go to next step.

No - Correct engagement or replace shaft. See “Transaxle Disassembly” on page 423.

(18) Pump/motor rotating groups not scoring on case/cylinder block mating surfaces, or scoring on pistons?

Yes - Go to next step.

No - Replace rotating groups and center case. See “Transaxle Disassembly” on page 423.

(19) Motor shaft with gear not damaged or worn?

Yes - Go to next step.

No - Replace shaft. See “Transaxle Disassembly” on page 423.

(20) Final pinion and ring gear not damaged or worn?

Yes - Go to next step.

No - Replace damaged or worn components. See “Transaxle Disassembly” on page 423.

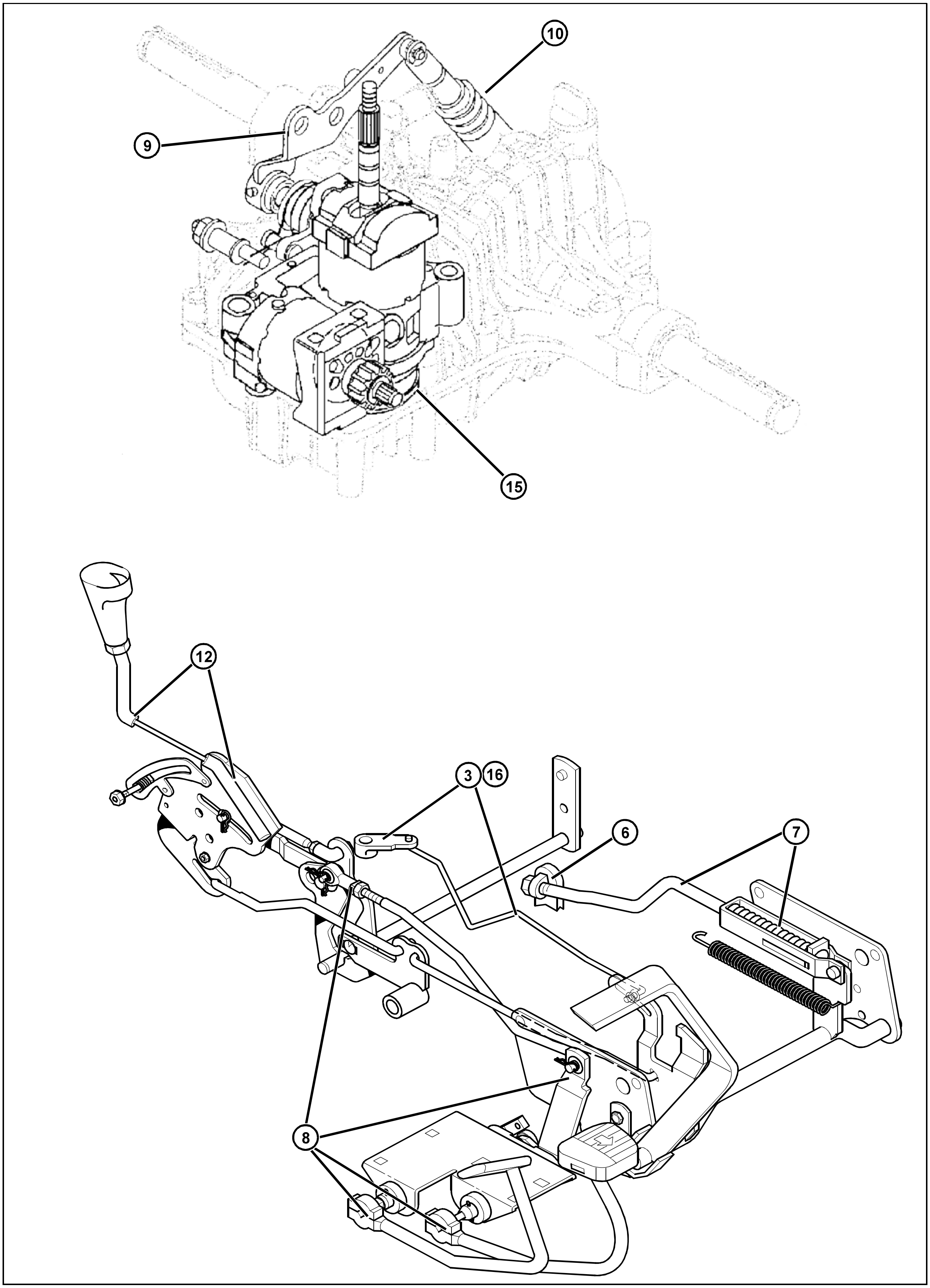
(21) Differential gears not damaged?

Yes - Go to next step.

No - Replace gears. See “Transaxle Disassembly” on page 423.

(22) Axle shafts not damaged?

No - Replace axle shafts. See “Transaxle Disassembly” on page 423.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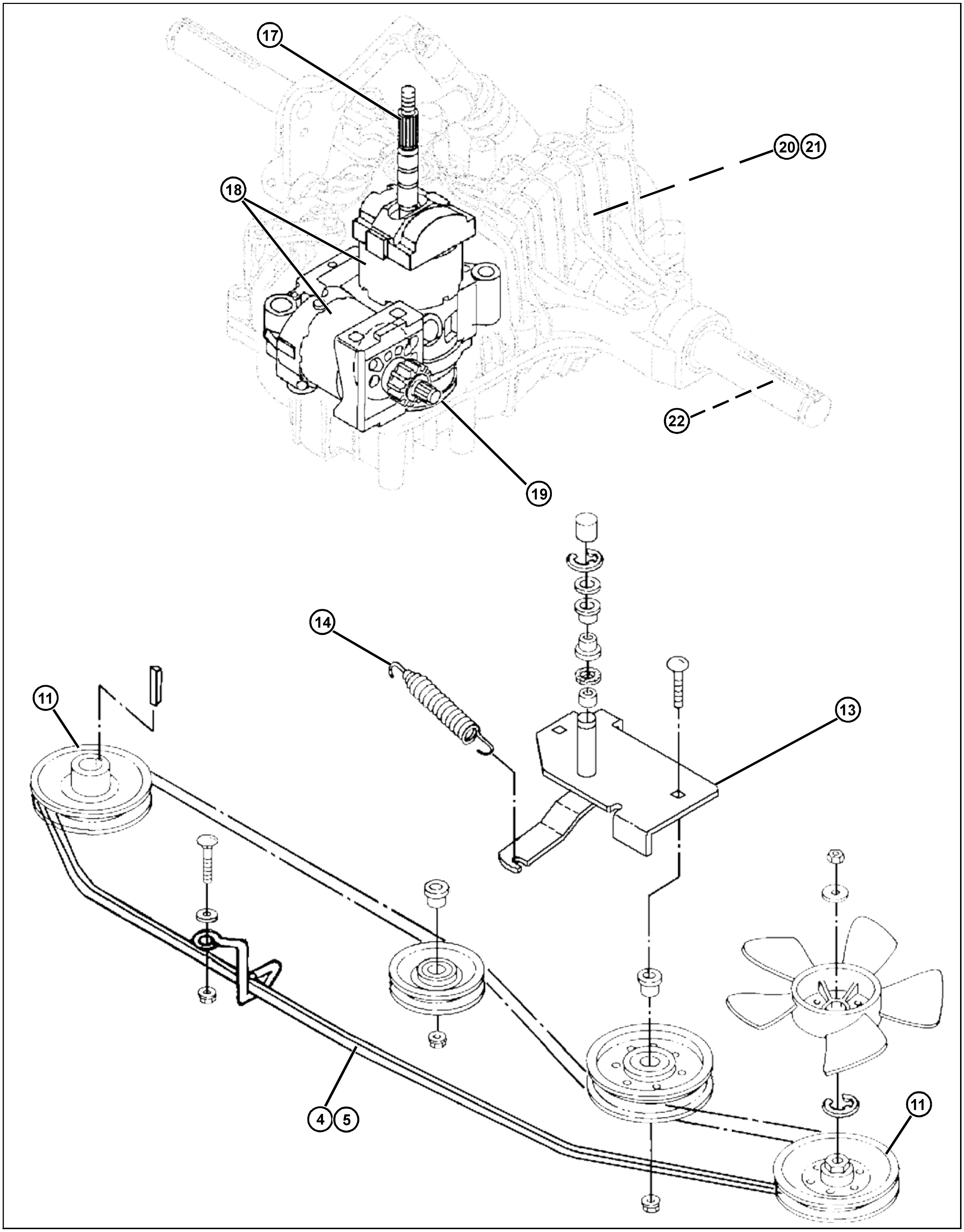
M95070, MIF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M99638, M95065 **Picture Note: 2WS Model Shown**

Noisy Operation

Test Conditions:

- Machine parked on level surface.
- Key switch in STOP position.
- Park brake UNLOCKED.
- Transaxle in NEUTRAL.

NOTE: Steps 5 through 8 require removal of transaxle from machine.

Symptom: Noisy Operation

(1) Hydrostatic reservoir oil at full mark, at operating temperature, clean and not foamy?

Yes - Go to next step.

No - Fill reservoir to correct level. Drain transaxle and fill to correct level with specified oil. Bleed air from system. See “Hydrostatic Transaxle Bleeding Procedure” on page 407.

(2) Park brake released?

Yes - Go to next step.

No - Release park brake.

(3) Brake linkage adjusted properly, brake rod and lever not damaged or binding?

Yes - Go to next step.

No - Adjust brake linkage. See “Brake Linkage Adjustment” on page 410. Eliminate binding and/or replace damaged components.

(4) Freewheel linkage and lever move freely and are not damaged?

Yes - Go to next step.

No - Eliminate binding and/or replace damaged components.

(5) Hydrostatic oil filter is free of debris, not plugged?

Yes - Go to next step.

No - Replace filter.

(6) Pump/motor rotating groups not scoring on case/cylinder block mating surfaces, or scoring on pistons?

Yes - Go to next step.

No - Replace rotating groups and center case. See “Transaxle Disassembly” on page 423.

(7) Check valve spools move freely, components not damaged?

Symptom: Noisy Operation

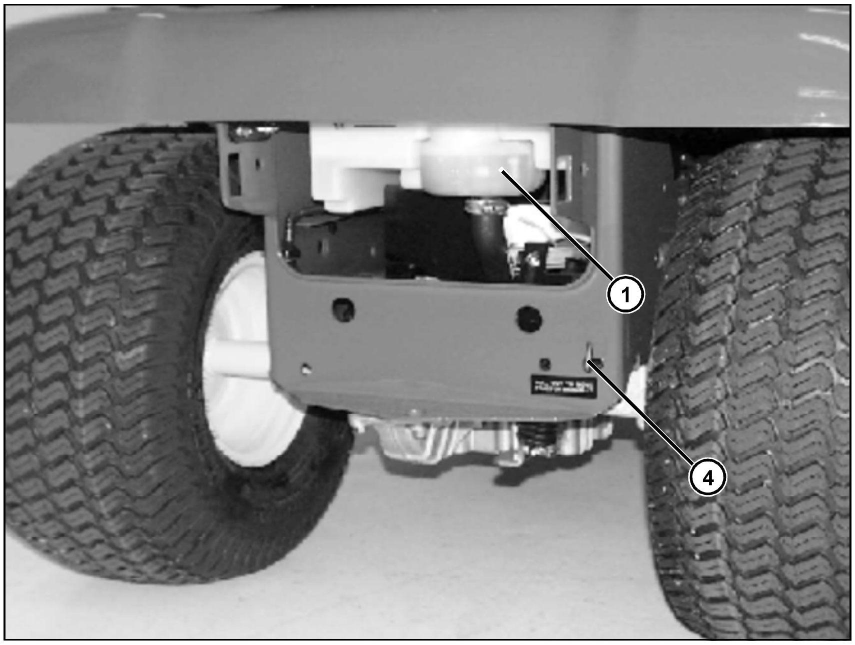
Yes - Go to next step.

No - Clean, free up valves or replace valves. See “Transaxle Disassembly” on page 423.

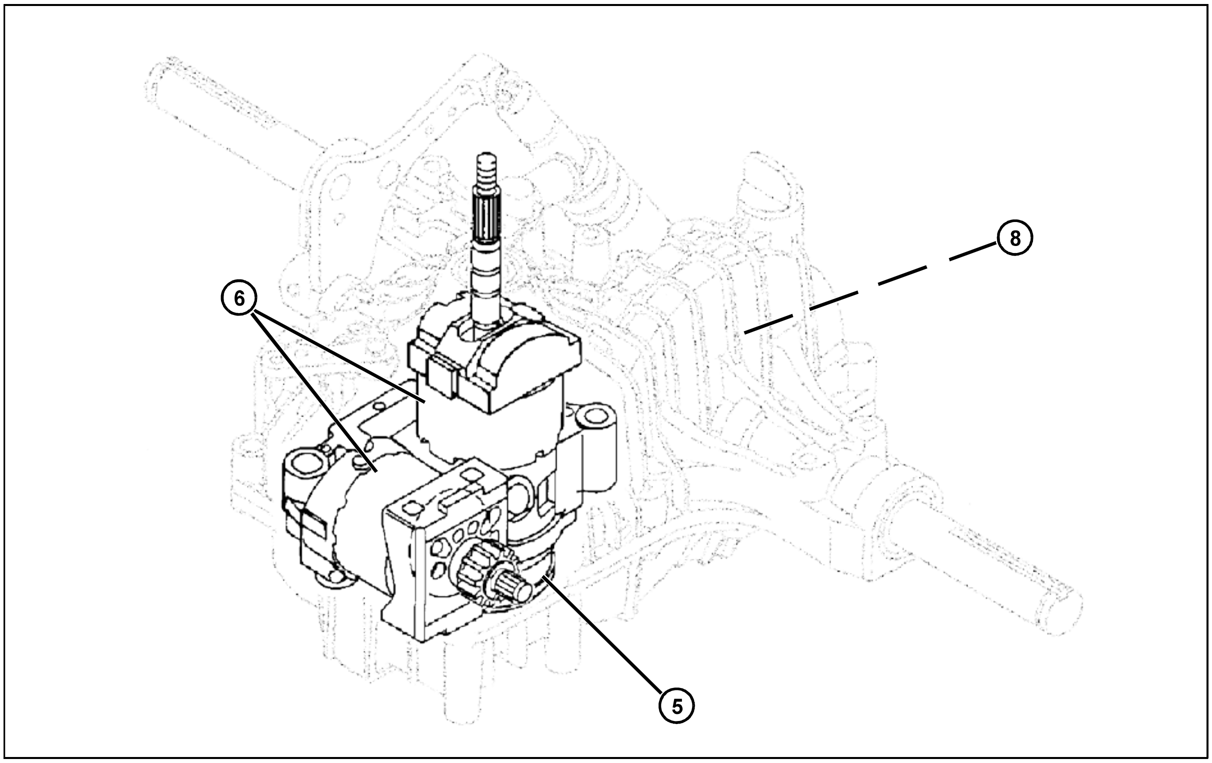
(8) Final pinion and ring gear not damaged or worn?

Yes - Go to next step.

No - Replace damaged or worn components. See “Transaxle Disassembly” on page 423.



MX8394



M95065

Machine Creeps

Test Conditions:

- Machine parked on level surface.
- Key switch in STOP position.
- Park brake UNLOCKED.
- Transaxle in NEUTRAL.

NOTE: Steps 8 through 9 require removal of transaxle from machine.

Symptom: Machine Creeps

(1) Hydrostatic transaxle oil to full mark?

Yes - Go to next step.

No - Fill reservoir to correct level with specified oil.

(2) Is the forward/reverse pedal linkage properly adjusted?

Yes - Go to next step.

No - Adjust linkage. See “Forward and Reverse Pedal Height Adjustment” on page 409.

(3) Does the forward/reverse pedal linkage move freely?

Yes - Go to next step.

No - Eliminate binding, replace faulty or damaged components. See “Control Pedals and Linkage” on page 443.

(4) Are the control arm and spring pin intact and present?

Yes - Go to next step.

No - Replace control arm and/or spring pin.

(5) Is the shock absorber binding or damaged?

Yes - Replace shock absorber.

No - Go to next step.

(6) Is the neutral eccentric properly adjusted for no wheel movement at fast idle?

Yes - Go to next step.

No - Adjust neutral eccentric. See “Neutral Creep Adjustment” on page 407.

(7) Variable position swash plate shaft ends, transaxle case bearings not worn or damaged, and thrust washers nor binding?

Yes - Go to next step.

No - Replace damaged or worn components. See “Transaxle Disassembly” on page 423.

Symptom: Machine Creeps

(8) Swash plate and control lever not bent or worn?

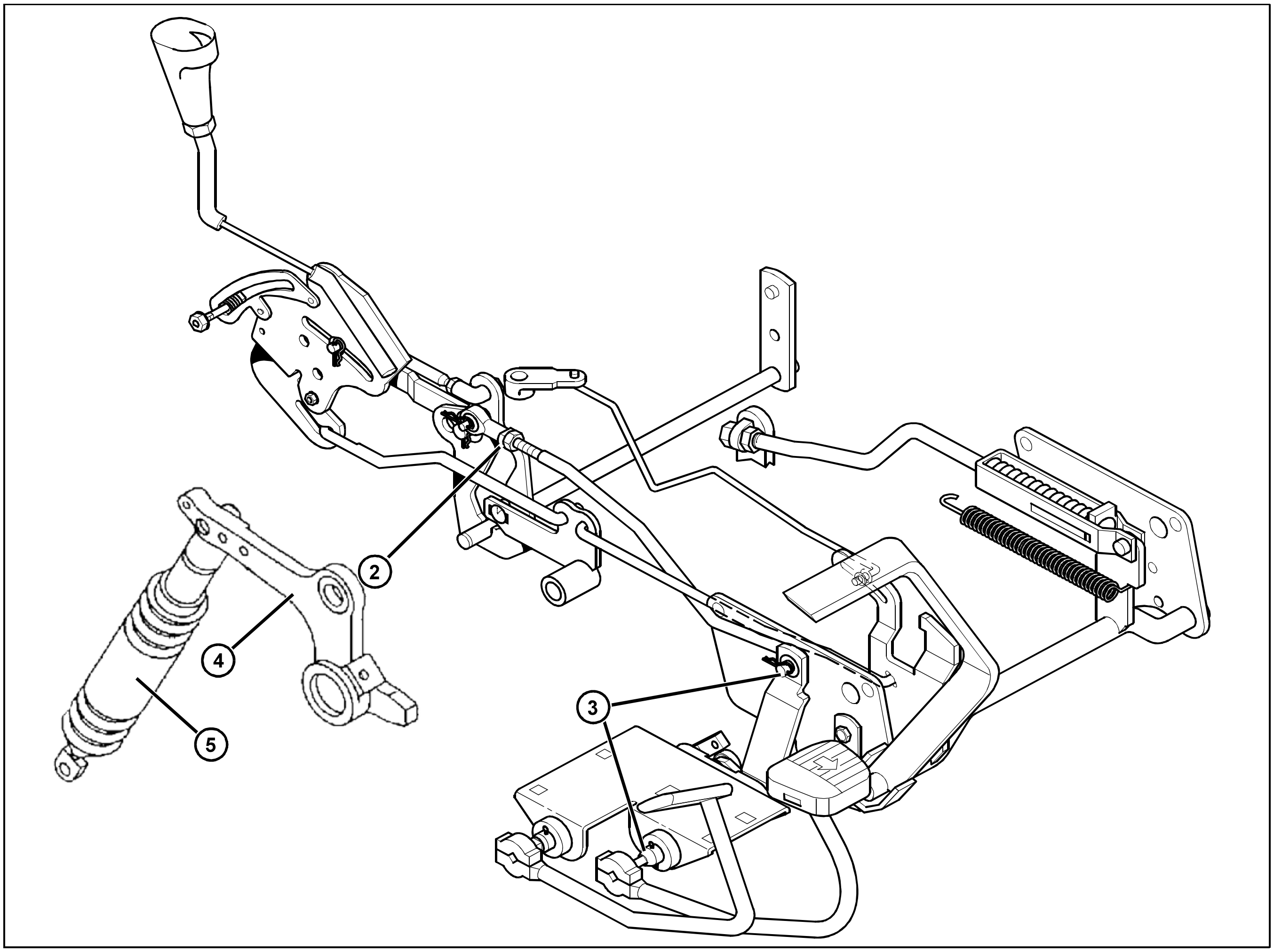
Yes - Go to next step.

No - Replace damaged or worn components. See “Transaxle Disassembly” on page 423.

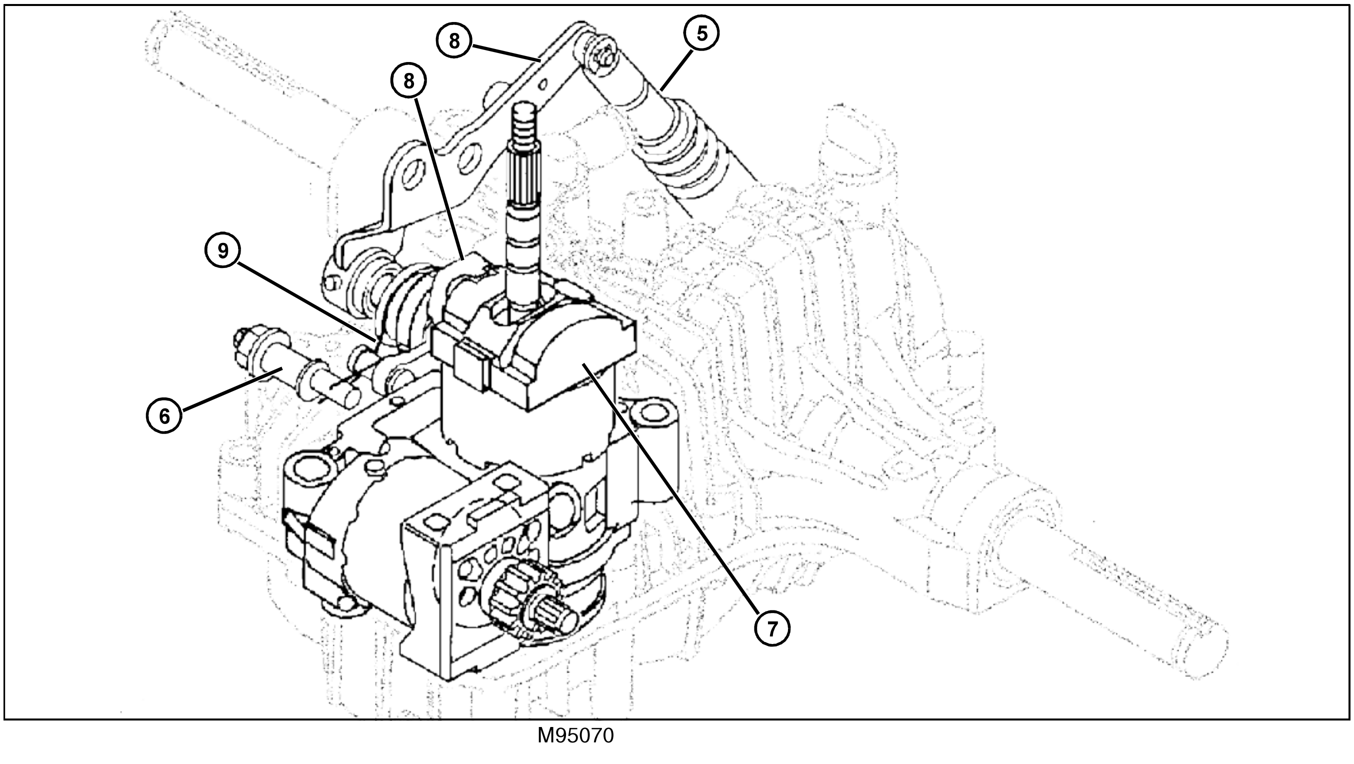
(9) Neutral return spring returns swash plate to neutral when forward/reverse pedals are released?

No - Replace damaged or worn components. See “Transaxle Disassembly” on page 423.

MX8394



M99578, MIF



M95070

Machine Moves In One Direction Only

Test Conditions:

- Machine parked on level surface.
- Key switch in STOP position.
- Park brake UNLOCKED.
- Transaxle in NEUTRAL.

NOTE: Step 5 requires removal of transaxle from machine.

Symptom: Machine Moves In One Direction Only

(1) Is the forward/reverse pedal linkage properly adjusted?

Yes - Go to next step.

No - Adjust linkage. See “Forward and Reverse Pedal Height Adjustment” on page 409.

(2) Does the forward/reverse pedal linkage move freely?

Symptom: Machine Moves In One Direction Only

Yes - Go to next step.

No - Eliminate binding, replace faulty or damaged components. See “Control Pedals and Linkage” on page 443.

(3) Is the shock absorber binding or damaged?

Yes - Replace shock absorber.

No - Go to next step.

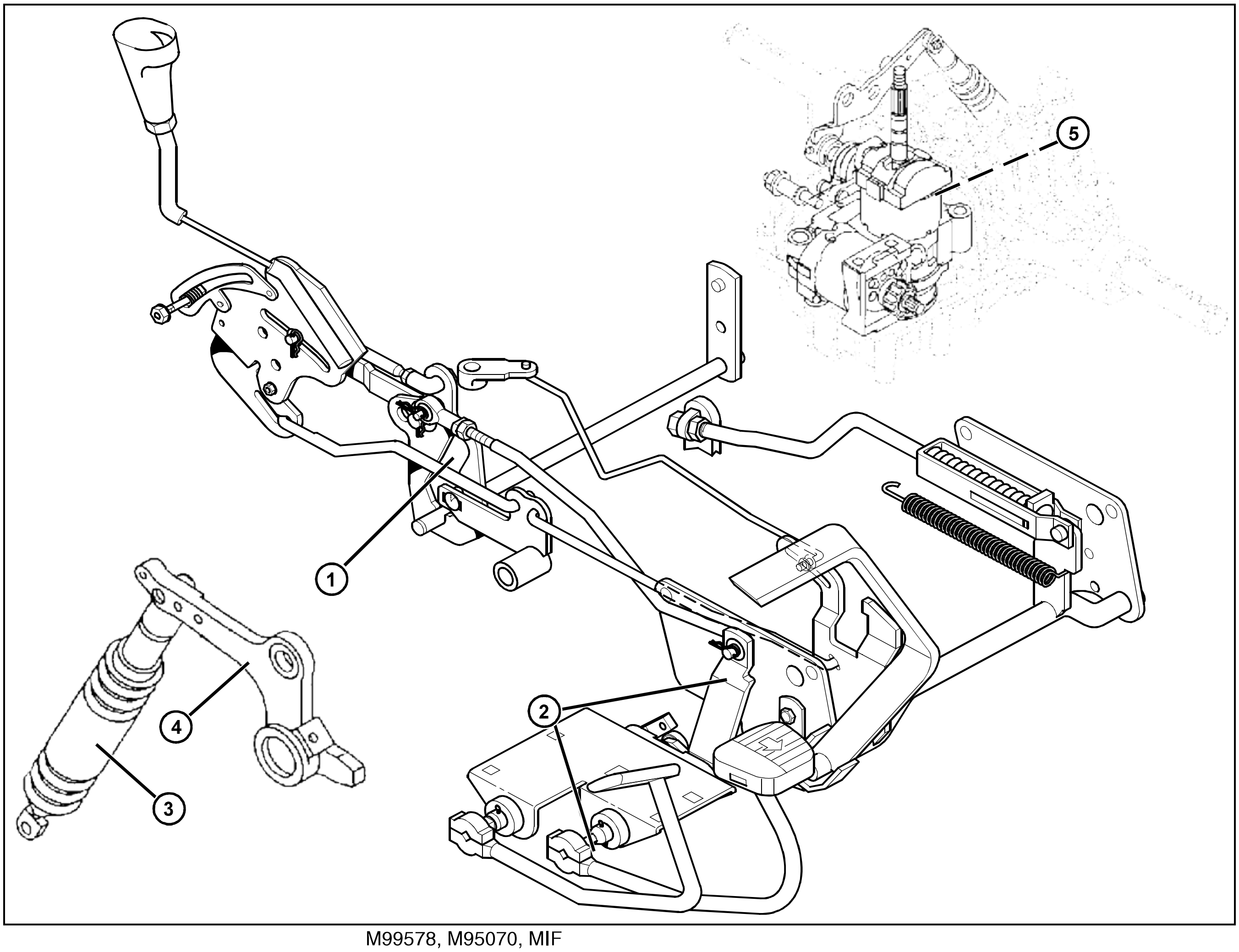
(4) Is the control arm free of damage?

Yes - Go to next step.

No - Replace control arm and/or spring pin.

(5) Reverse check valve moves freely, not stuck in open position?

No - Clean, free up valve or replace valve. See “Transaxle Disassembly” on page 423.



M99578, M95070, MIF

Erratic Speed

Test Conditions:

- Machine parked on level surface.
- Key switch in STOP position.
- Park brake UNLOCKED.
- Transaxle in NEUTRAL.

NOTE: Steps 5 through 8 require removal of transaxle from machine.

Symptom: Erratic Speed

(1) Hydrostatic reservoir oil at full mark, at operating temperature, clean and not foamy?

Yes - Go to next step.

No - Fill reservoir to correct level. Drain transaxle and fill to correct level with specified oil. Bleed air from system. See “Hydrostatic Transaxle Bleeding Procedure” on page 407.

(2) Is the traction belt worn, frayed, glazed or stretched?

Yes - Replace traction belt. See “Traction Drive Belt Removal and Installation” on page 439.

No - Go to next step.

(3) Is the traction belt properly tensioned?

Yes - Go to next step.

No - Check belt tensioning. See “Traction Drive Belt Tensioner Assembly” on page 442.

(4) Brake linkage adjusted properly, brake rod and lever not damaged or binding?

Yes - Go to next step.

No - Adjust brake linkage. See “Brake Linkage Adjustment” on page 410. Eliminate binding and/or replace damaged components.

(5) Hydrostatic oil filter is free of debris, not plugged?

Yes - Go to next step.

No - Replace filter.

(6) Pump/motor rotating groups not scoring on case/cylinder block mating surfaces, or scoring on pistons?

Yes - Go to next step.

No - Replace rotating groups and center case. See “Transaxle Disassembly” on page 423.

(7) Motor shaft with gear not damaged or worn?

Symptom: Erratic Speed

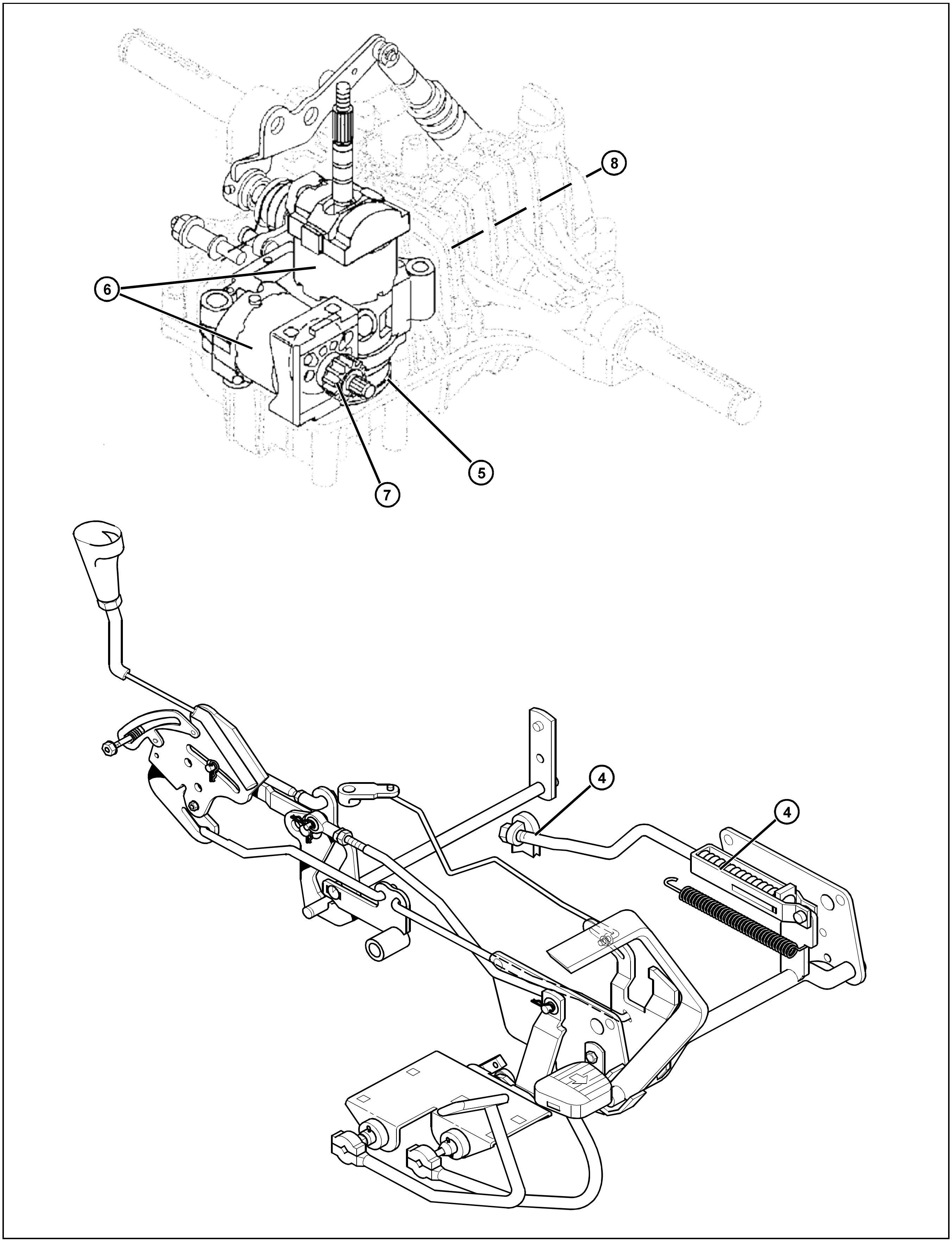
Yes - Go to next step.

No - Replace shaft. See “Transaxle Disassembly” on page 423.

(8) Final pinion and ring gear not damaged or worn?

Yes - Go to next step.

No - Replace damaged or worn components. See “Transaxle Disassembly” on page 423.



M95070, MIF

Machine Does Not Achieve Full Ground Speed

Test Conditions:

- Machine parked on level surface.
- Key switch in STOP position.
- Park brake UNLOCKED.
- Transaxle in NEUTRAL.

NOTE: Steps 12 through 15 require removal of transaxle from machine.

Symptom: Machine Does Not Achieve Full Ground Speed

(1) Transaxle free of debris?

Yes - Go to next step.

No - Remove debris from transaxle.

(2) Cooling fan not damaged?

Yes - Go to next step.

No - Replace cooling fan.

(3) Hydrostatic reservoir oil at full mark, at operating temperature, clean and not foamy?

Yes - Go to next step.

No - Fill reservoir to correct level. Drain transaxle and fill to correct level with specified oil. Bleed air from system. See “Hydrostatic Transaxle Bleeding Procedure” on page 407.

(4) Is the traction belt worn, frayed, glazed or stretched?

Yes - Replace traction belt. See “Traction Drive Belt Removal and Installation” on page 439.

No - Go to next step.

(5) Is the traction belt properly tensioned?

Yes - Go to next step.

No - Check belt tensioning. See “Traction Drive Belt Tensioner Assembly” on page 442.

(6) Is the park brake set?

Yes - Release park brake.

No - Go to next step.

(7) Swash plate and control lever not bent or worn?

Yes - Go to next step.

No - Replace damaged or worn components. See “Transaxle Disassembly” on page 423.

Symptom: Machine Does Not Achieve Full Ground Speed

(8) Brake linkage adjusted properly, brake rod and lever not damaged or binding?

Yes - Go to next step.

No - Adjust brake linkage. See “Brake Linkage Adjustment” on page 410. Eliminate binding and/or replace damaged components.

(9) Is the forward/reverse pedal linkage properly adjusted?

Yes - Go to next step.

No - Adjust linkage. See “Forward and Reverse Pedal Height Adjustment” on page 409.

(10) Does the forward/reverse pedal linkage move freely?

Yes - Go to next step.

No - Eliminate binding, replace faulty or damaged components. See “Control Pedals and Linkage” on page 443.

(11) Is the shock absorber binding or damaged?

Yes - Replace shock absorber.

No - Go to next step.

(12) Hydrostatic oil filter is free of debris, not plugged?

Yes - Go to next step.

No - Replace filter.

(13) Pump/motor rotating groups not scoring on case/cylinder block mating surfaces, or scoring on pistons?

Yes - Go to next step.

No - Replace rotating groups and center case. See “Transaxle Disassembly” on page 423.

(14) Freewheel linkage and lever move freely and are not damaged?

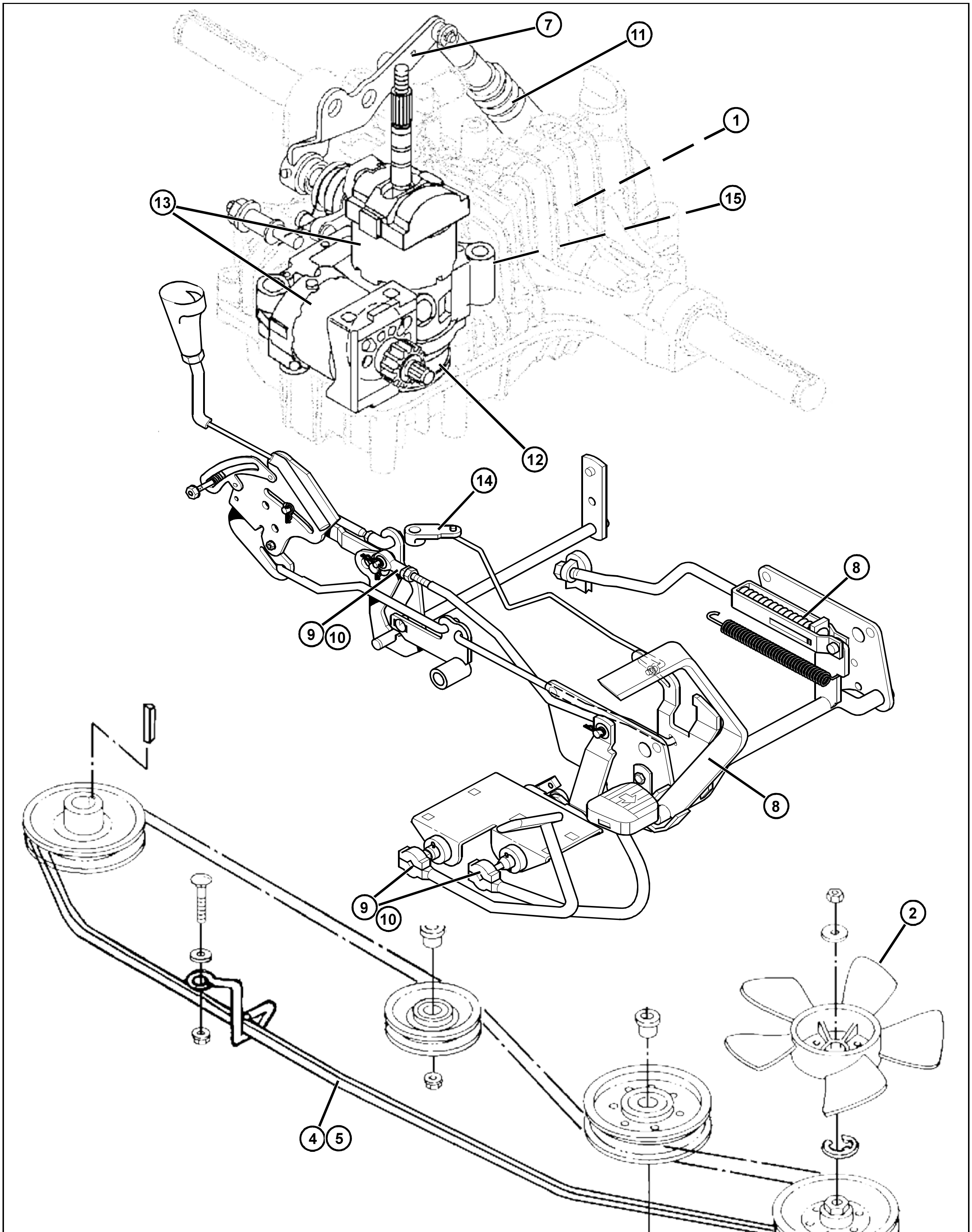
Yes - Go to next step.

No - Eliminate binding and/or replace damaged components.

(15) Check valve spools move freely, components not damaged?

Yes - Go to next step.

No - Clean, free up valves or replace valves. See “Transaxle Disassembly” on page 423.



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M95070, M95586, MIF

Park Brake Does Not Hold Machine On Hill

Test Conditions:

- Machine parked on level surface.
- Key switch in STOP position.
- Park brake UNLOCKED.
- Transaxle in NEUTRAL.

NOTE: Steps 12 through 15 require removal of transaxle from machine.

Symptom: Park Brake Does Not Hold Machine On Hill

(1) Brake pedal and linkage are not damaged, worn, or binding?

Yes - Go to next step.

No - Eliminate binding and/or replace damaged components.

(2) Park brake lever and linkage are not damaged, worn, or binding?

Yes - Go to next step.

No - Eliminate binding and/or replace damaged components.

(3) Brake disk, shoe and brake assembly are not damaged, worn, or binding?

Yes - Go to next step.

No - Eliminate binding and/or replace damaged components. See “Transaxle Disassembly” on page 423.

(4) Motor shaft with gear not damaged or worn?

Yes - Go to next step.

No - Replace shaft. See “Transaxle Disassembly” on page 423.

(5) Reduction shaft and gear not worn or damaged?

Yes - Go to next step.

No - Replace damaged or worn components. See “Transaxle Disassembly” on page 423.

(6) Final pinion and ring gear not damaged or worn?

Yes - Go to next step.

No - Replace damaged or worn components. See “Transaxle Disassembly” on page 423.

(7) Differential gears not damaged?

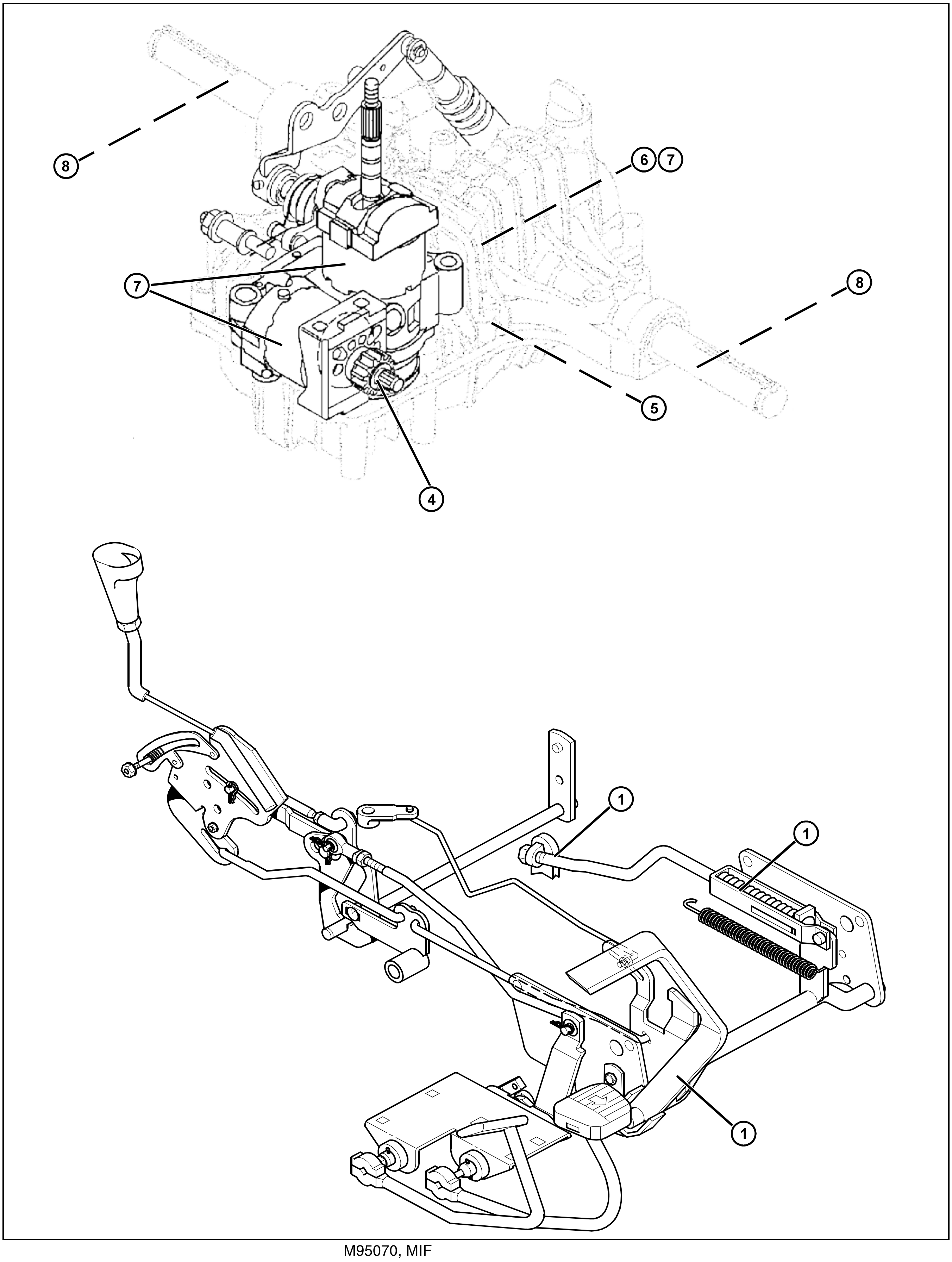
Symptom: Park Brake Does Not Hold Machine On Hill

Yes - Go to next step.

No - Replace gears. See “Transaxle Disassembly” on page 423.

(8) Axle shafts not damaged?

No - Replace axle shafts.See “Transaxle Disassembly” on page 423.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M95070, MIF

Brake Switch Will Not Engage

Test Conditions:

- Machine parked on level surface.
- Key switch in STOP position.
- Park brake UNLOCKED.
- Transaxle in NEUTRAL.

Symptom: Brake Switch Will Not Engage

(1) Transaxle free of debris?

Yes - Go to next step.

No - Remove debris from transaxle.

(2) Is the forward/reverse pedal linkage properly adjusted?

Yes - Go to next step.

No - Adjust linkage. See “Forward and Reverse Pedal Height Adjustment” on page 409.

(3) Does the forward/reverse pedal linkage move freely?

Yes - Go to next step.

No - Eliminate binding, replace faulty or damaged components. See “Control Pedals and Linkage” on page 443.

(4) Brake linkage adjusted properly, brake rod and lever not damaged or binding?

Yes - Go to next step.

No - Adjust brake linkage. See “Brake Linkage Adjustment” on page 410. Eliminate binding and/or replace damaged components.

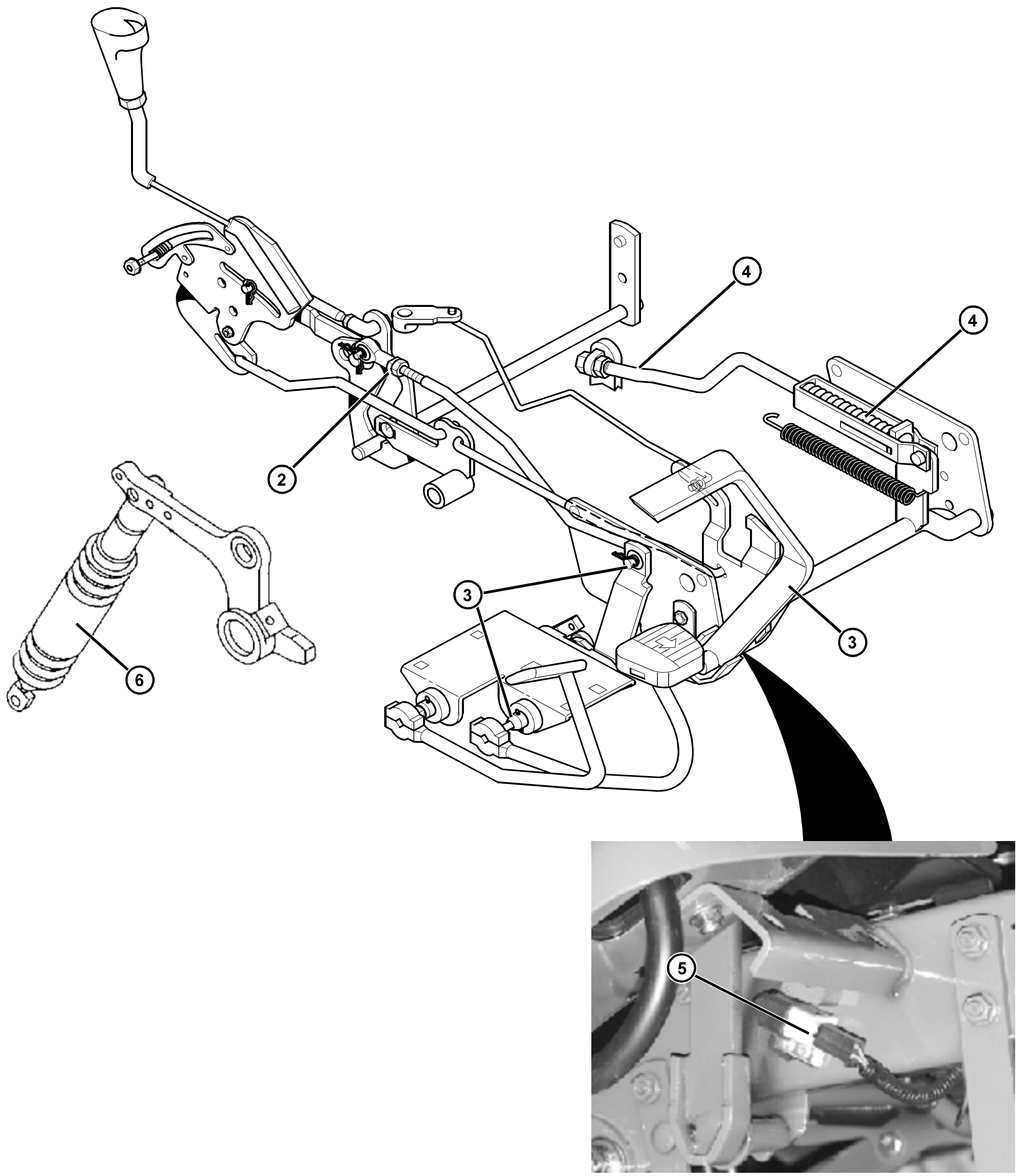
(5) Does the brake switch have continuity with park brake locked?

Yes - Go to next step.

No - Test brake switch. See “Brake/Neutral Start Switch Test” on page 343 in the Electrical section. Replace switch as needed.

(6) Is the shock absorber binding or damaged?

Yes - Replace shock absorber.



MIF, M99578, M99582

Cruise Control Does Not Maintain Ground Speed

Test Conditions:

- Machine parked on level surface.
- Key switch in STOP position.
- Park brake UNLOCKED.
- Transaxle in NEUTRAL.

NOTE: Steps 12 through 15 require removal of transaxle from machine.

Symptom: Cruise Control Does Not Maintain Ground Speed

(1) Cruise control lever and linkage move freely, not damaged, and maintain position when set?

Yes - Go to next step.

No - Eliminate binding, replace faulty or damaged components as needed. Adjust lever tension

(2) Is the forward/reverse pedal linkage properly adjusted?

Symptom: Cruise Control Does Not Maintain Ground Speed

Yes - Go to next step.

No - Adjust linkage. See “Forward and Reverse Pedal Height Adjustment” on page 409.

(3) Does the forward/reverse pedal linkage move freely?

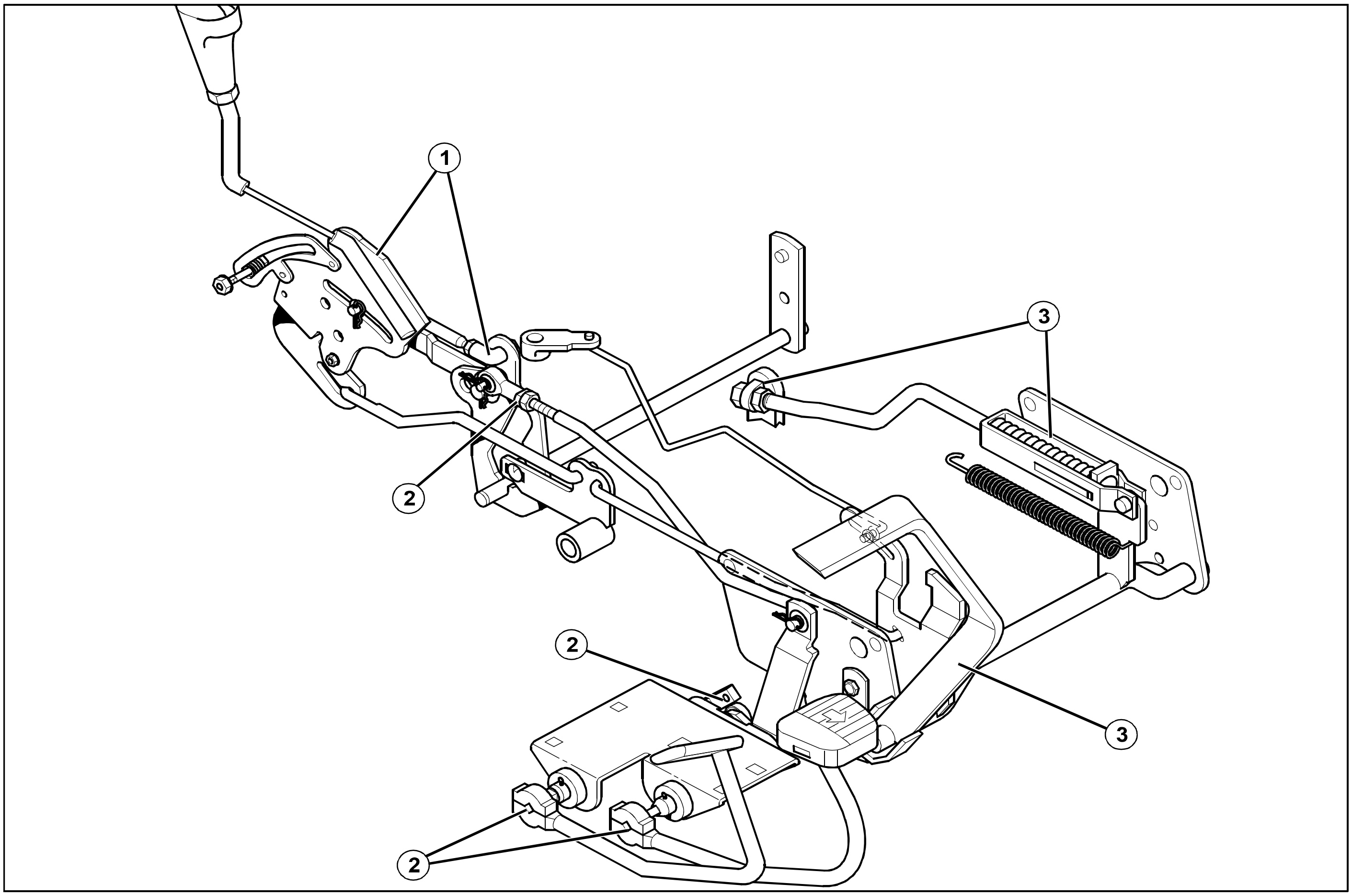
Yes - Go to next step.

No - Eliminate binding, replace faulty or damaged components. See “Control Pedals and Linkage” on page 443.

(4) Brake linkage adjusted properly, brake rod and lever not damaged or binding?

Yes - Go to next step.

No - Adjust brake linkage. See “Brake Linkage Adjustment” on page 410. Eliminate binding and/or replace damaged components.



MIF

Transaxle Whines When Brake Is Used

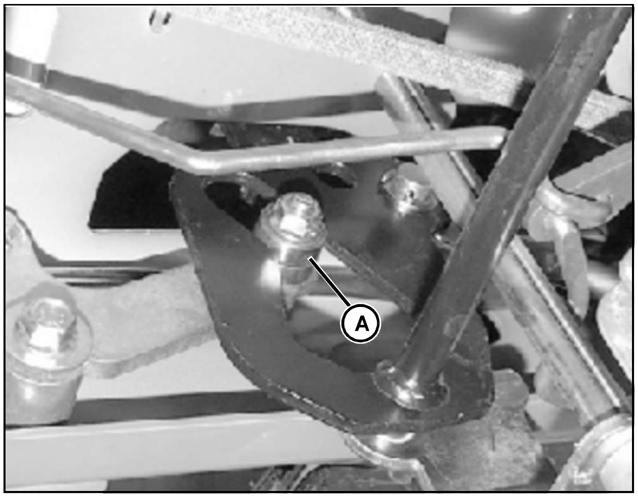
Test Conditions:

- Machine on level surface.
- Key switch in RUN position.
- Park brake LOCKED.
- Transaxle in NEUTRAL.

Symptom: Transaxle Whines When Brake Is Used

(1) Transaxle whines when brake is used, or park brake is set?

Yes - Adjust neutral return arm bearing (A). See "Neutral Return Arm Bearing Adjustment" on page 410.



M99616

Tests and Adjustments

Hydrostatic Transaxle Bleeding Procedure

Reason:

This procedure is performed to eliminate air from the hydrostatic transaxle after repair or leakage of the transaxle.

Procedure:

Check hydrostatic transaxle oil reservoir oil level. If necessary, fill to correct level with oil.

1. Raise rear wheels off the ground. Support rear axles with jack stands.
2. Start and run engine at SLOW idle.

CAUTION: Avoid injury! Keep hands away from transaxle cooling fan and wheels during procedure to avoid injury.

3. While alternately depressing the forward and reverse pedals, engage and disengage the freewheel valve lever. Continue this procedure until the rear wheels start to rotate. This step may take 5 to 10 minutes to perform.
4. Turn off engine and lower the machine to the ground.
5. With engine off and control pedals in neutral, push the machine forward and then rearward to turn the motor rotating group.
6. Start and run the engine at FAST idle.
7. Quickly depress and release the forward and reverse pedals until the machine moves without hesitation.

Results:

- Machine moves without hesitation when forward or reverse pedals are depressed.

Neutral Creep Adjustment

Reason:

If the machine creeps forward or backward with the forward/reverse pedals in the neutral position, parking brake released, and the engine running, the neutral eccentric must be adjusted.

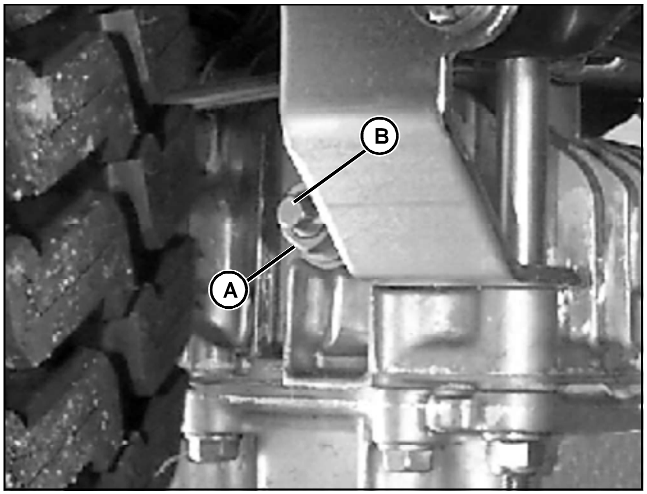
Procedure:

1. Park machine on level surface.
2. Turn key switch to STOP position.
3. Move forward/reverse pedals to NEUTRAL position.
4. Remove mower deck from machine.

5. Lift rear of machine until wheels are off the ground, and support machine with jack stand.

6. Place blocks in front of and behind front wheels.

NOTE: The eccentric shaft (B) is located on the right side of the transmission above and forward of the right hand axle.



M95063

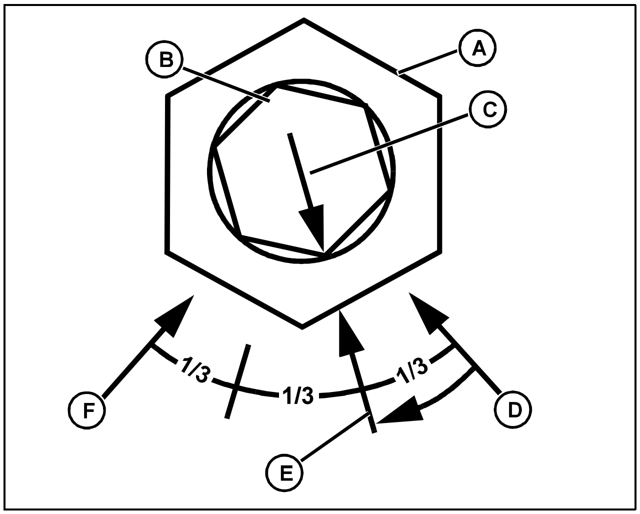
7. Remove right hand rear wheel.

CAUTION: Avoid injury! Keep hands away from transaxle cooling fan and wheels during procedure to avoid injury.

NOTE: Engine will not start with seat switch disconnected. Use a jumper wire to bypass switch.

8. Start and run engine at FAST idle.

NOTE: If axle shafts do not rotate in reverse after turning the eccentric shaft one full turn, see steps 15 - 17.



MIF

9. Loosen locknut (A) and turn the eccentric shaft (B) clockwise until the axle shaft(s) rotates in reverse. Mark (C) the top of the eccentric shaft for position.

10.Turn the eccentric shaft slowly counterclockwise until the axle shaft(s) stops rotating. Mark the transaxle case as the reverse stop position (F).

11.Turn the eccentric shaft slowly counterclockwise until the axle shaft(s) rotates forward.

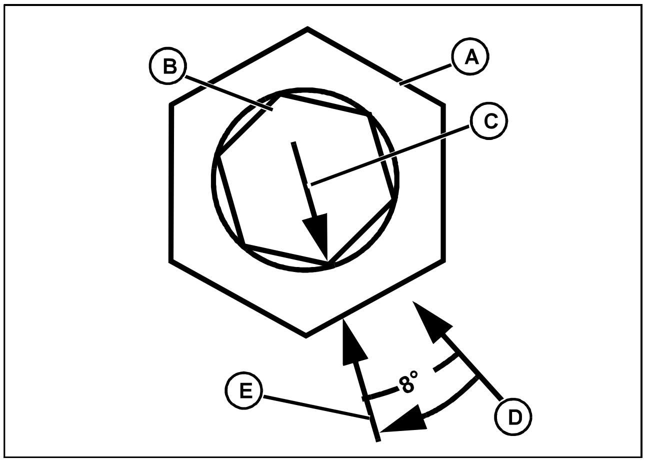
12.Turn the eccentric shaft clockwise until the axle shaft(s) stops rotating. Mark the transaxle case as the forward stop position (D).

13.Turn the eccentric shaft slowly clockwise until the mark is approximately 1/3 the distance between the forward and reverse stop positions. This is neutral position (E).

14.Hold eccentric shaft with wrench and tighten locknut.

NOTE: If the axle shafts do not rotate in reverse although the eccentric shaft has been turned one full turn, adjust neutral as follows:

15.Turn eccentric shaft counterclockwise until axle shaft(s) rotate forward.



MIF

16.Turn eccentric shaft (B) clockwise until the axle shaft stops. Mark (C) the top of the eccentric shaft and transaxle case.

17.Turn the eccentric shaft clockwise approximately 8× from forward stop position (D).

18.Hold eccentric shaft with wrench and tighten locknut (A).

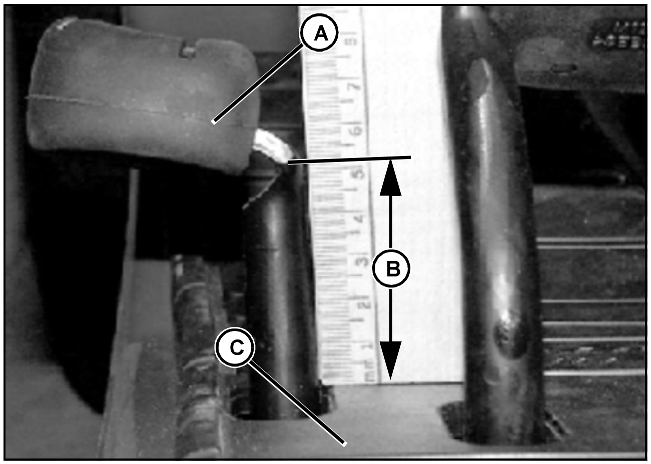
Forward and Reverse Pedal Height Adjustment

Reason:

To ensure full travel speeds can be reached in forward and reverse directions. This also ensures that the transaxle swash plate and control arm will not act as a mechanical stop for the pedal linkage.

Procedure:

1. Press reverse pedal (A) twice and allow pedal to return to neutral position.

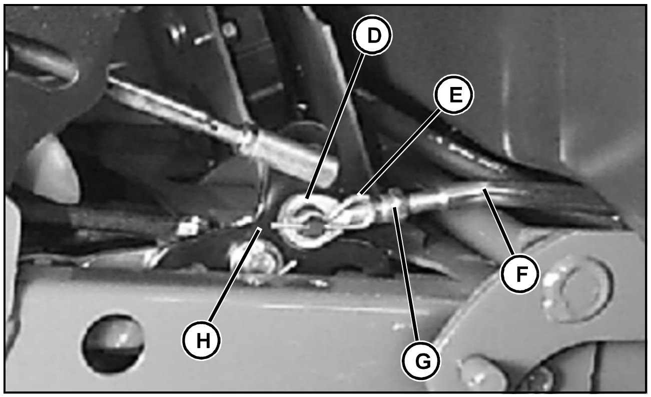


M99617

2. Measure reverse pedal height (B) from top of foot mat (C) to tooling mark on front edge of pedal bracket as shown. Correct reverse pedal height is 50 mm ± 2 mm (1.97 in. ± 0.08 in.).

3. Proper tool mark location is where sheared steel edge intersects with round portion of pedal bracket.

If not within specification, adjust foot pedal rod length:



M95315

1. In front of right rear wheel, locate jam nut (G) on forward/reverse control rod (F). Loosen jam nut.

2. Remove spring clip pin (E) and disconnect forward/ reverse control rod from intermediate shaft plate (H).

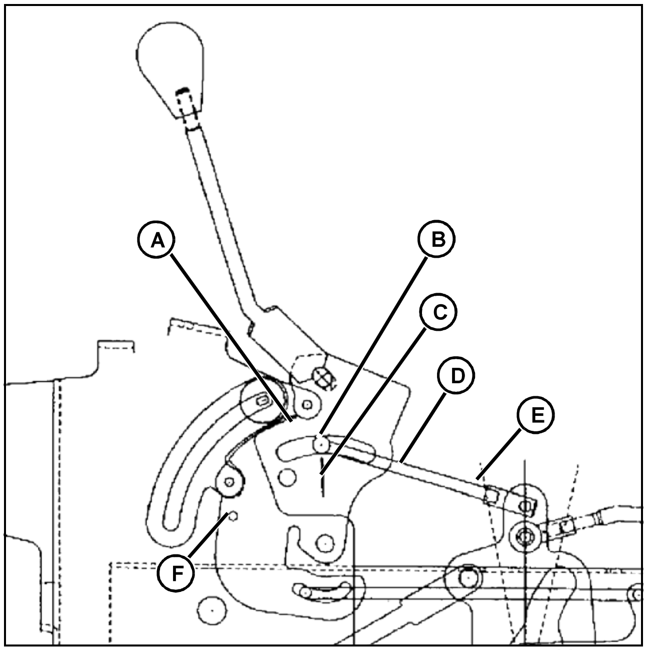
3. Turn ball joint rod end (D) on end of control rod:
   - Lengthen the rod to raise the reverse pedal.
   - Shorten the rod to lower the reverse pedal.

4. Reconnect control rod to control lever and retain with spring clip pin.

5. Press reverse pedal twice and allow to return to neutral. Check measurement. Repeat adjustment procedure until within specification.

Hand Lever Rod Adjustment

1. Park machine on level surface.
2. Turn key switch to STOP position.
3. Unlock park brake.
4. Press reverse pedal twice and allow pedals to return to NEUTRAL.
5. Pull hand control lever (A) to rear most position.

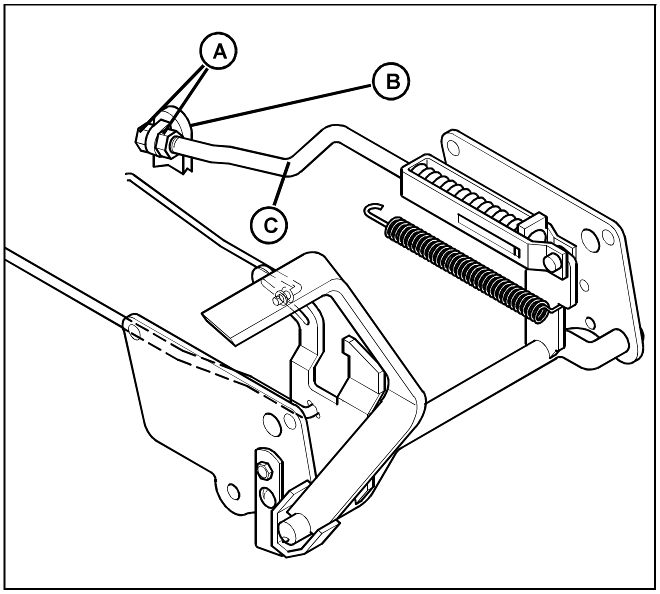


M99619

6. Align 6 mm alignment hole (F) in hand lever plate with 6 mm hole in frame side. Insert a 6 mm drill bit through holes.
7. Loosen jam nut (E) on hand lever rod (D).
8. Remove cotter pin and bushing (B) and disconnect hand lever rod from hand lever.
9. Turn rod to adjust length so that centerline of rod end and is aligned with alignment mark (C) as shown.
10. Reconnect rod to hand lever. Retain with bushing and cotter pin.

Brake Linkage Adjustment

1. Park machine on level surface.
2. Turn key switch to STOP position.
3. Remove mower deck. See "Mower Deck Removal and Installation" for the appropriate mower deck in the Attachments section.
4. Remove cotter pin and washer attaching brake rod to transmission brake arm. Disconnect brake rod from transmission brake arm.
5. Inspect transmission brake arm and brake pedal and linkage. Be sure that both transmission brake arm and brake pedal are in full rearward (OFF) positions.



MIF

6. Loosen two jam nuts (A) and adjust length of brake rod (C) so that rod end fits into hole in transaxle brake arm (B).
7. Tighten jam nuts.
8. Install washer and cotter pin.

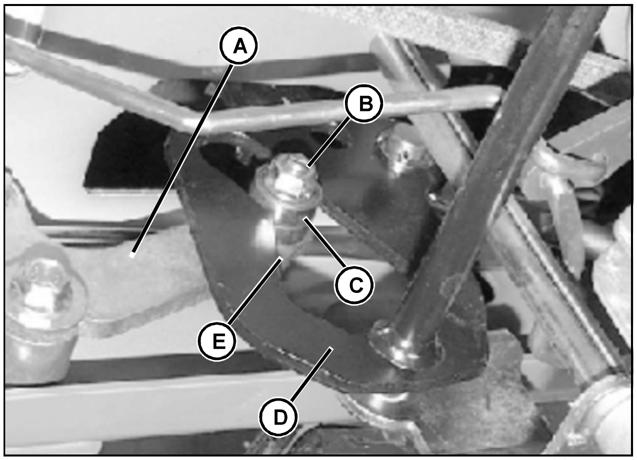
Neutral Return Arm Bearing Adjustment

Reason:

To ensure that brake pedal and neutral shaft do not engage forward or reverse when brake pedal is depressed. This also ensures that the transaxle is not in forward or reverse when park brake is locked, causing transaxle to whine.

Procedure:

1. Park machine on level surface.
2. Turn key switch to STOP position.
3. Move forward/reverse pedals or hand control to NEUTRAL position. Lock park brake.
4. Remove mower deck. See Mower Deck Removal and Installation for the appropriate mower deck in the Attachments section.



M99616

5. Underneath machine, locate and loosen nut (B) on bearing end of neutral return arm (A).
6. Adjust ball bearings (C) back and forth by sliding carriage bolt in slot in neutral return arm. Position bearings so that they are centered in cam profile slot (E) in the intermediate shaft plate (D).
7. Release park brake and have an assistant depress the brake pedal several times. Ball bearings should not move intermediate shaft. If ball bearings move intermediate shaft, repeat steps 5 and 6.

Cruise/Hand Control Lever Tension Adjustment

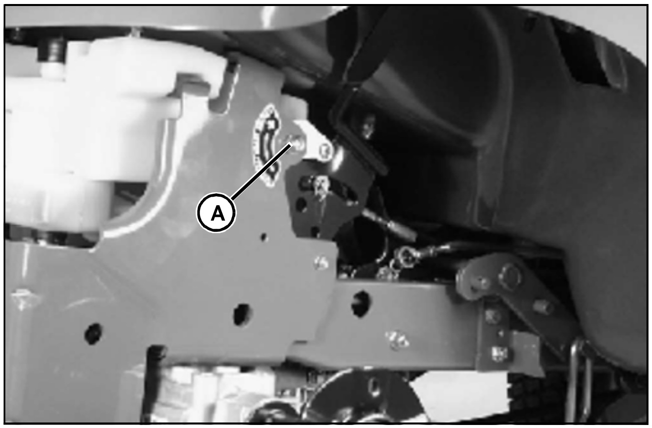
Purpose:

To adjust friction mechanism that holds the cruise/hand control lever in position. Mechanism may require adjustment due to wear or operator preference.

Procedure:

1. Locate adjusting nut in right rear wheel well.

NOTE: Rear wheel removed for clarity. Adjustments can be made without removing wheel.



M96061

2. Turn adjustment nut (A) to change cruise control lever tension:

- Increase tension - turn nut clockwise
- Decrease tension - turn nut counterclockwise

Adjust tension so that lever can be easily moved in both forward and rearward direction.

Lever should hold transmission linkage in any position set.

Repair

Transaxle Removal and Installation - 2WS Models

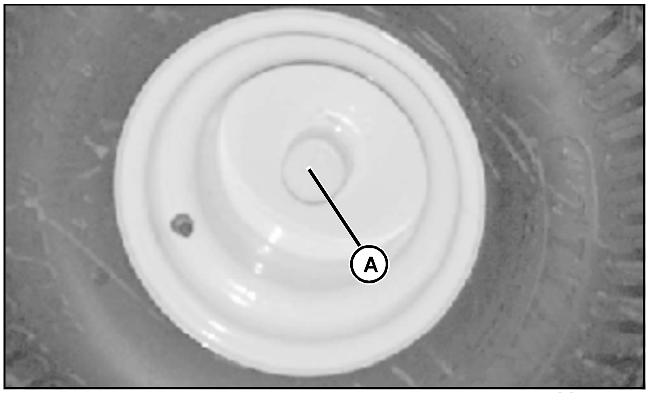
Removal:

1. Remove mower deck. See Mower Deck Removal and Installation for the appropriate mower deck in the Attachments section.

2. Remove fender deck. See “Fender Deck Removal and Installation” on page 590 in the Miscellaneous section.

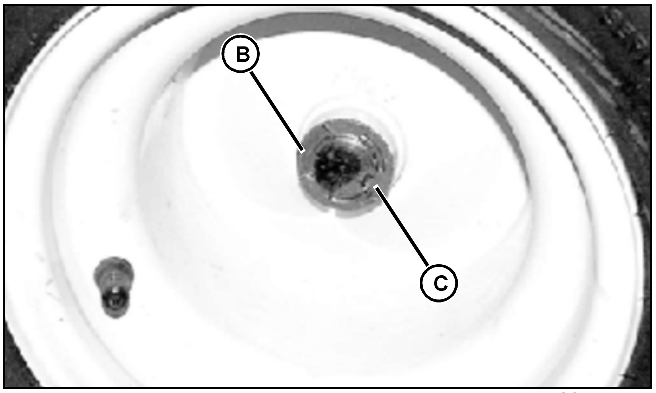
IMPORTANT: Avoid damage! During transaxle removal, rear of machine must be supported by the frame.

3. Raise rear of machine and support on suitable stands.



M99621

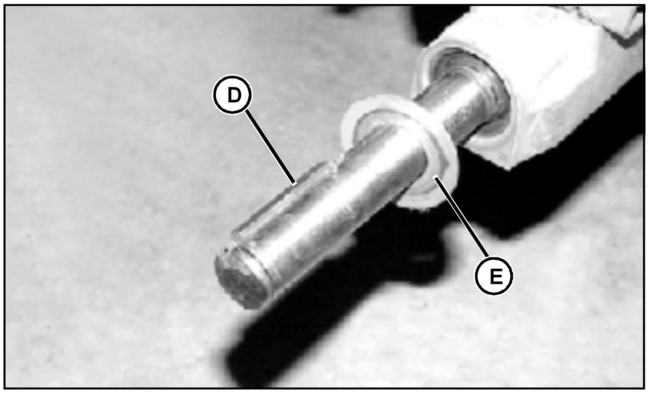
4. Remove wheel center caps (A).



M99622

5. Remove E-clips (C) and washers (B).

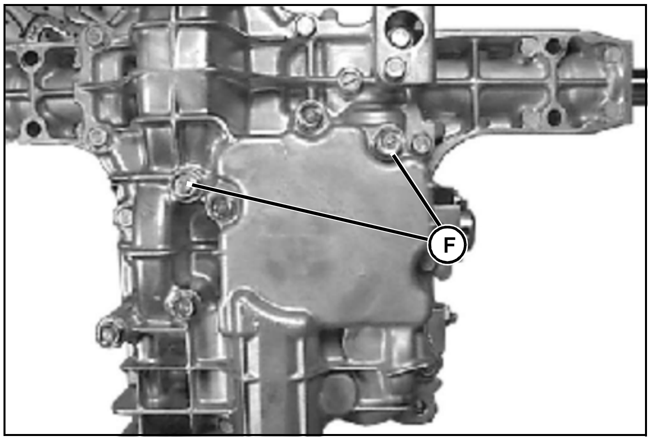
6. Remove wheel and tire assemblies.



M99621

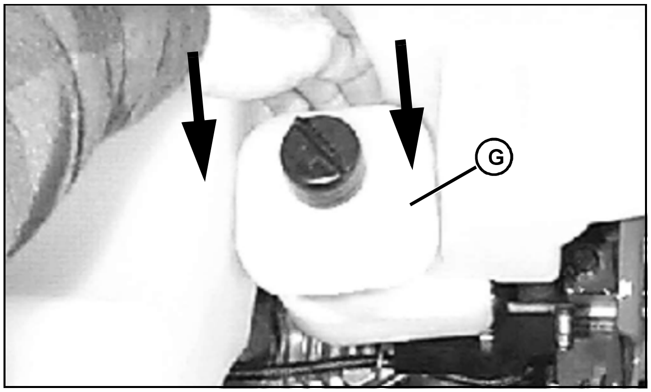
7. Remove keys (D) and thrust washers (E) from axle shafts.

NOTE: Capacity of the transaxle is approximately 2.5 L (2.7 qt). Have a suitable container ready before removing drain plug.



M94895

8. Remove drain bolts (F). Drain transaxle oil into a suitable container.

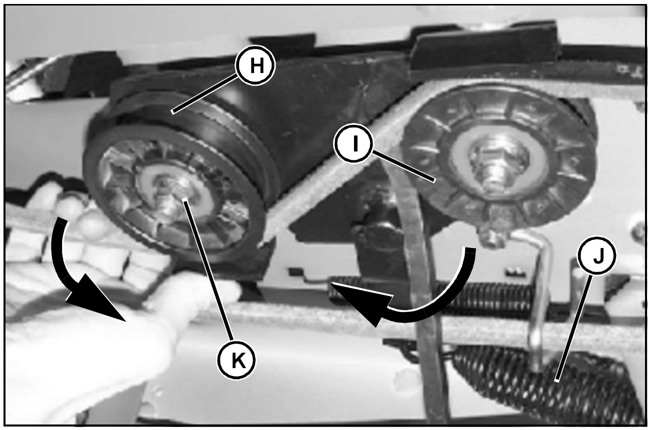


M95320

9. Push hydrostatic transaxle oil reservoir (G) rearward, and disconnect it from the fuel tank.

CAUTION: Avoid injury! Gasoline is extremely flammable. Do not smoke. Always work in a ventilated area away from open flame or spark producing equipment; including equipment that utilizes pilot lights. Wipe-up any spills IMMEDIATELY.

10. Lift and remove fuel tank from machine frame. Set fuel tank aside.

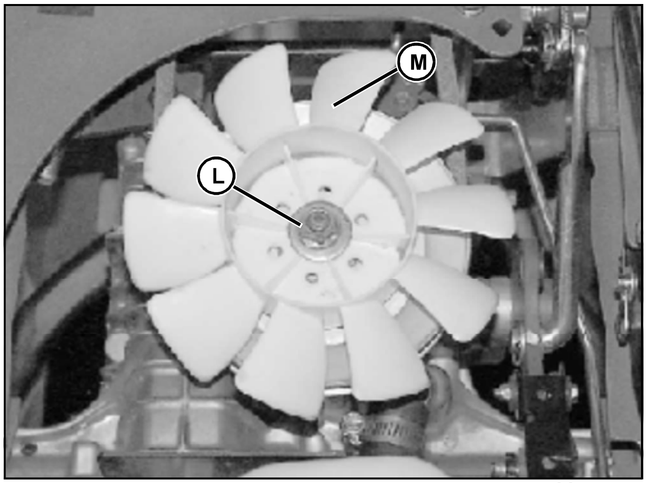


M99618

11. Loosen nut (K) on flat idler (H).

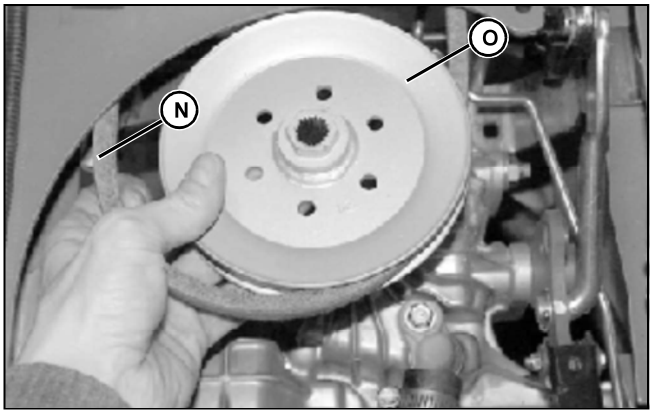
12. Disconnect traction drive spring (J).

13. Pull belt tensioner and slip belt off of flat idler and V-idler (I).

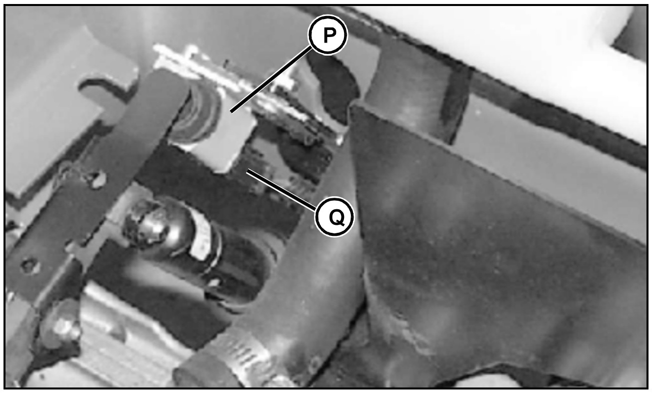


M99624

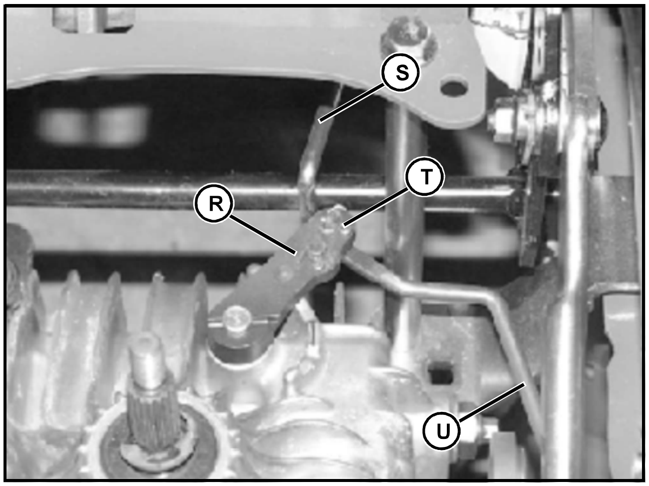
14. Remove locknut and washer (L), and transaxle cooling fan (M).



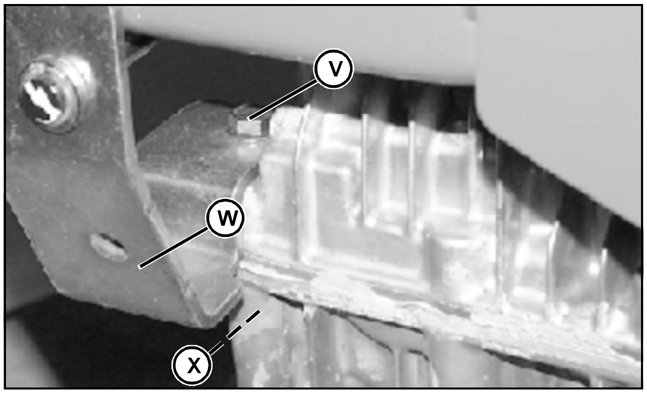
15.Lift input sheave (O) off top of transaxle. Slip drive belt (N) off of sheave and move aside. Remove sheave.



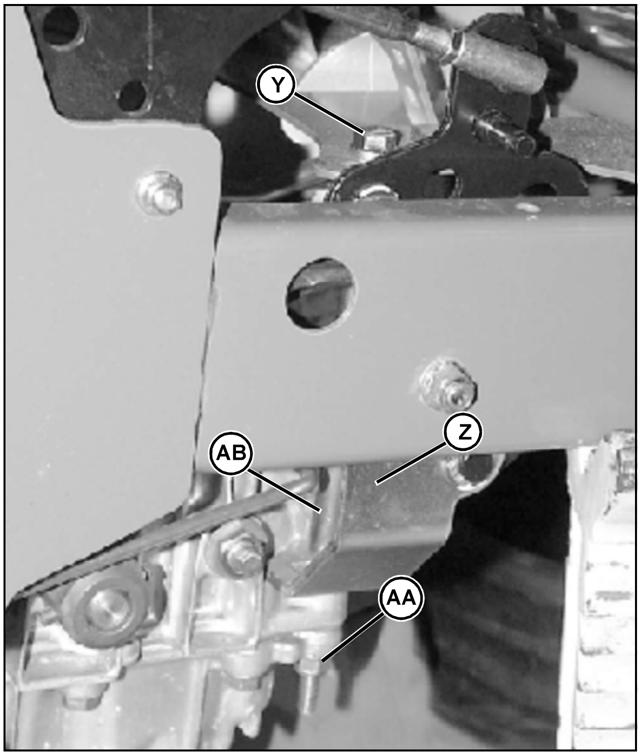
16.Disconnect RIO switch (P) wiring harness connector (Q).



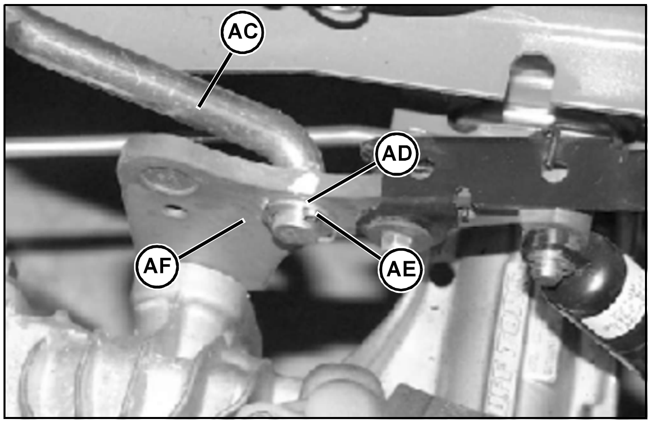
17.Remove two cotter pins (R and T) and disconnect freewheeling valve interlock rod (S) and control rod (U) from lever on transaxle.



18.On left side of machine, remove cap screw (V) and locknut (X) attaching transaxle to angle bracket (W).

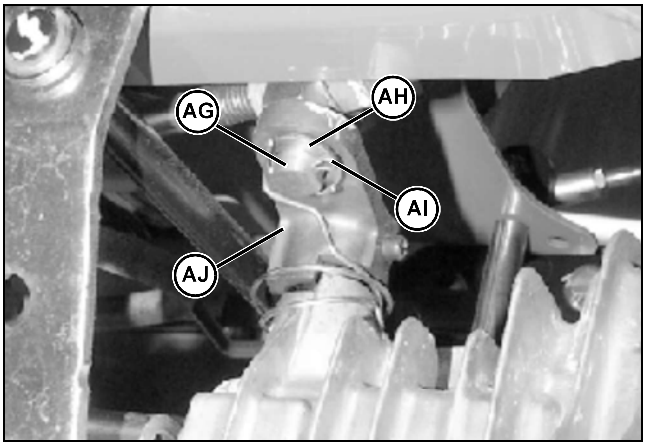


19.On right side of machine, remove cap screw (Y), spacer (AB), and locknut (AA) attaching transaxle to angle bracket (Z).



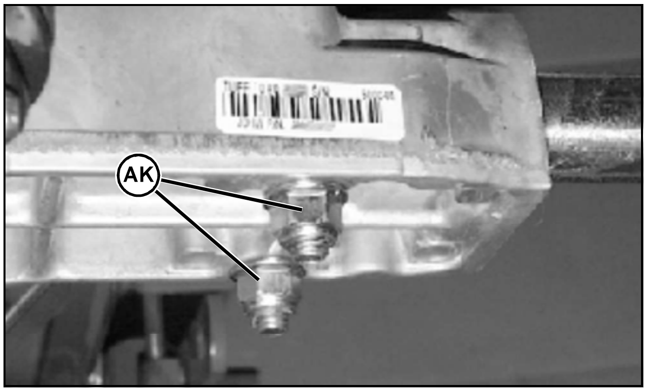
M99630

20.On right side of machine, remove cotter pin (AE) and washer (AD), and disconnect transaxle control rod (AC) from control lever (AF).



M99631

21.On left side of machine, remove cotter pin (AI) and washer (AH), and disconnect brake link (AG) from control lever (AJ).



M99680

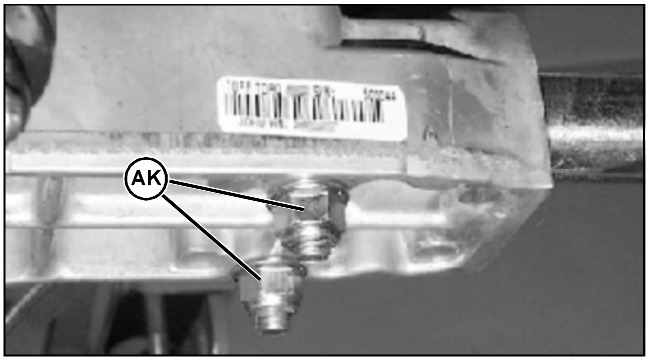
22.Using a transmission jack, support transaxle.

23.Remove four locknuts (AK) retaining transaxle to machine frame.

24.Lower transaxle and remove from frame.

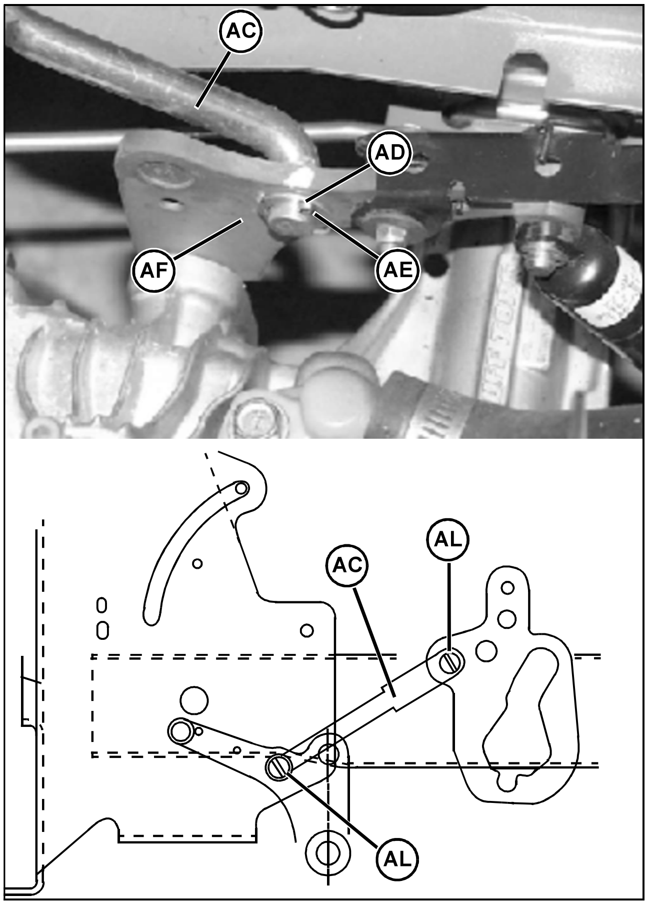
Installation:

1. Place transaxle on a transmission jack, and move into position beneath machine frame.



M99680

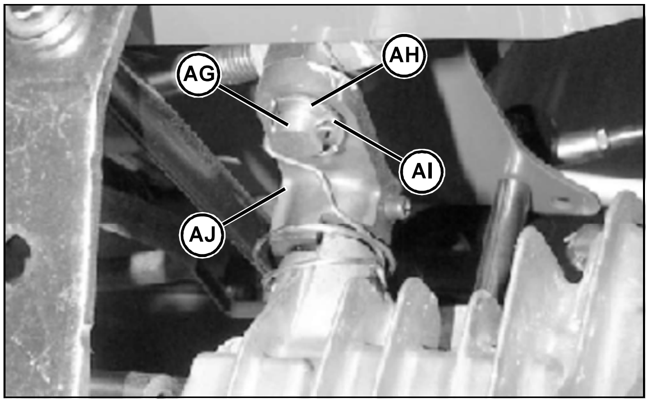
2. Raise transaxle into position and onto two U-bolts. Install four locknuts (AK) to retain transaxle to machine frame.



M99630/MIF

3. On right side of machine, connect transaxle control rod (AC) to control lever (AF). Retain with washer (AD) and cotter pin (AE).

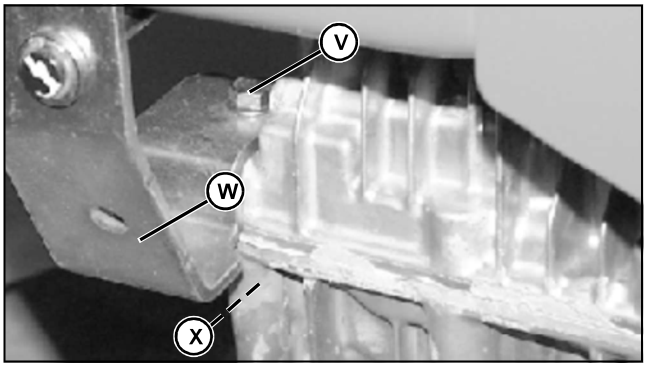
IMPORTANT: Avoid damage! Pay particular attention to holes (AL) control rod (AC) is placed in. Damage may occur if wrong holes are used.



M99631

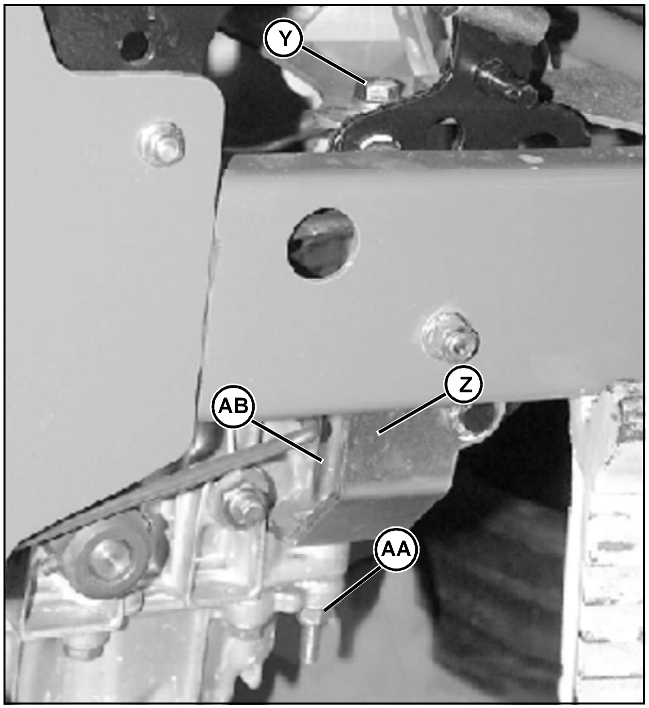
4. On left side of machine, connect brake link (AG) to control lever (AJ), and retain with washer (AH) and cotter pin (AI).

5. Raise transaxle into position, and install four cap screws, washers, and locknuts to retain transaxle to machine frame.



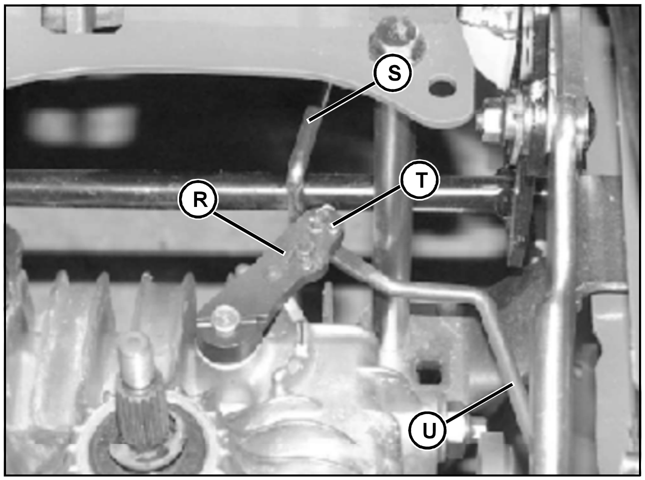
M99628

6. On left side of machine, install cap screw (V) and locknut (X) to attach transaxle to angle bracket (W).



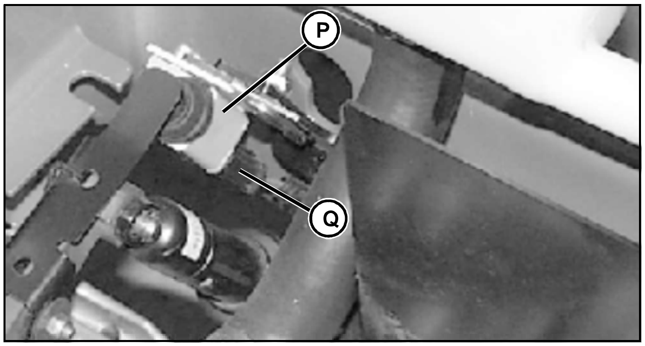
M99629

7. On right side of machine, install cap screw (Y), spacer (AB), and locknut (AA) to attach transaxle to angle bracket (Z).



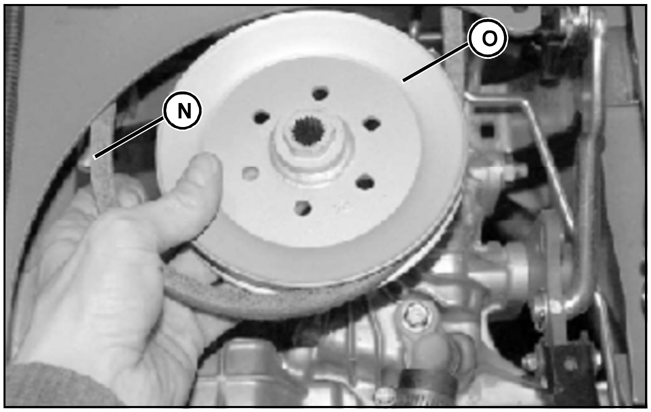
M99627

8. Connect freewheeling valve interlock rod (S) and freewheeling valve control rod (U) to lever on transaxle. Retain with cotter pins (R and T).



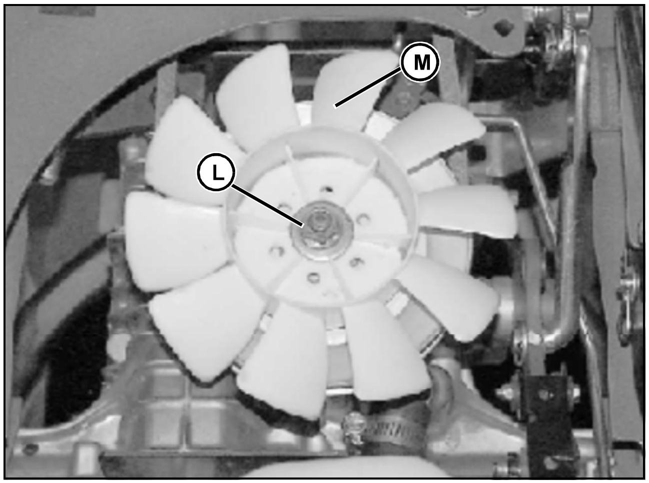
M99626

9. Connect RIO switch (P) wiring harness connector (Q).



M99625

10.Slip belt (N) onto input sheave (O) and install input sheave to top of transaxle.



M99624

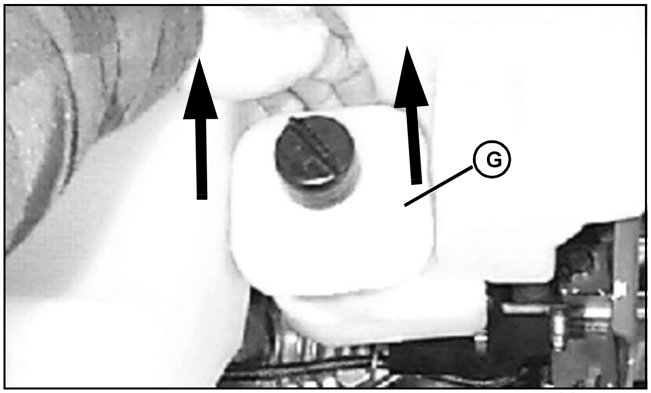
11.Install transaxle cooling fan (M) and retain with washer and locknut (L). Tighten locknut to 30 N•m (22 lb-ft).

CAUTION: Avoid injury! Gasoline is extremely flammable. Do not smoke. Always work in a ventilated area away from open flame or spark producing equipment; including equipment that utilizes pilot lights. Wipe-up any spills IMMEDIATELY.

12.Install fuel tank to machine frame.

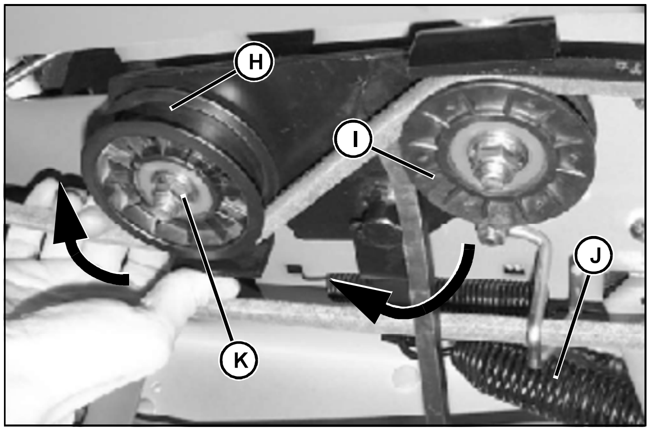
13.If removed, re-attach fuel hose tie down clamps.

14.Route seat switch wiring harness in groove in fuel tank next to fuel hose.



M95320

15.Attach hydrostatic transaxle oil reservoir (G) to the fuel tank.

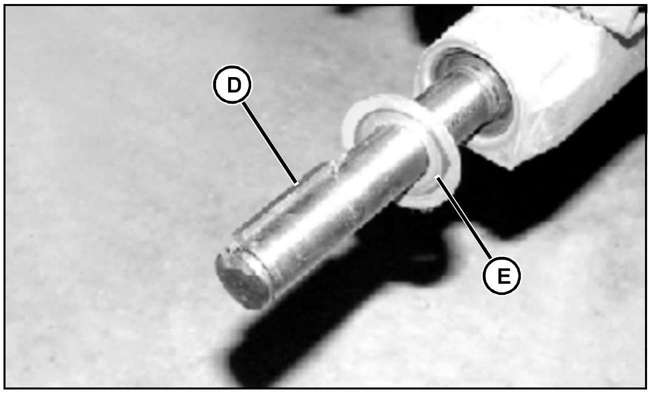


M99618

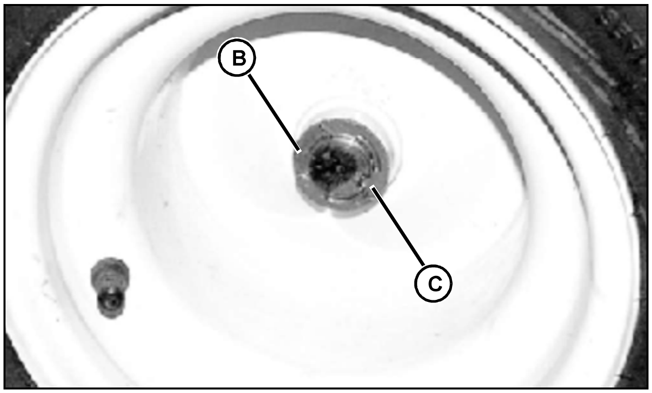
16.Pull belt tensioner assembly and slip belt onto flat idler (H) and V-idler (I).

17.Connect tension spring (J).

18.Tighten nut (K) on flat idler.

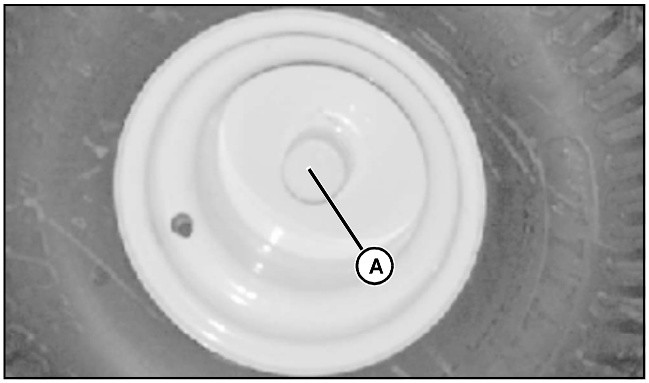


19.Install thrust washer (E) and key (D) to axle shafts.



20.Install wheel and tire assemblies.

21.Install washers (B) and E-clips (C).



22.Install wheel center caps (A).

23.Install fender deck. See “Fender Deck Removal and Installation” on page 590 in the Miscellaneous section.

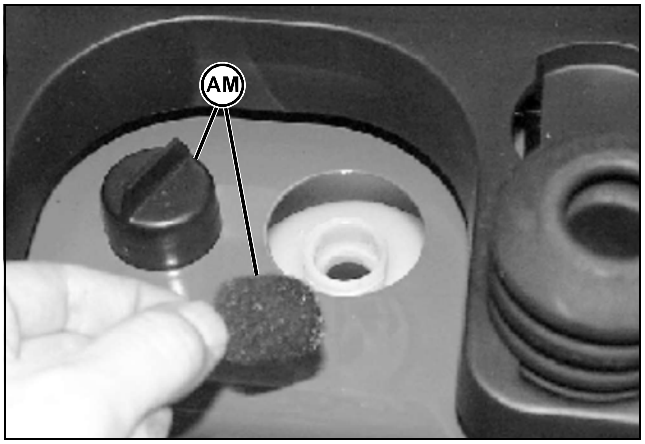
24.Raise rear of machine, and remove stands.

25.Lower machine to the ground.

IMPORTANT: Avoid damage! Avoid damage! Contamination can damage the hydraulic system. Clean thoroughly around fill caps before opening.

NOTE: Total transaxle capacity is approximately 2.5 L (2.7 qt).

26.Remove fill plug on left side at rear of transaxle. This plug will fill the differential gear side. Add approximately 1.25 L (1.3 qt) of SAE 5W or 10W30 Oil (Synthetic or Mineral) or John Deere HY-GARD™ J20C Oil. When oil is at bottom of threads in filler, install and tighten fill plug.



27.Remove filler cap and filter (AM) on reservoir bottle. The reservoir bottle tube will fill the hydrostatic transmission side. Add approximately 1.5 L (1.7 qt) of SAE 5W or 10W30 Oil (Synthetic or Mineral) or John Deere HY-GARD™ J20C Oil. When oil reaches FULL line on reservoir bottle, install and tighten filler cap.

28.Perform transaxle bleeding procedure. See “Hydrostatic Transaxle Bleeding Procedure” on page 407.

29.Start engine, unlock park brake and drive machine forward and backward.

30.Check for oil leaks.

31.Park machine on a level surface. Stop engine and check oil level in reservoir bottle. Add oil if needed to bring level up to FULL line.

32.Start engine and release park brake. If machine moves with engine running and hydrostatic control in neutral, perform neutral creep adjustment. See “Neutral Creep Adjustment” on page 407.

33.Install mower deck. See Mower Deck Removal and Installation for the appropriate mower deck in the Attachments section.

Transaxle Removal and Installation - AWS Models

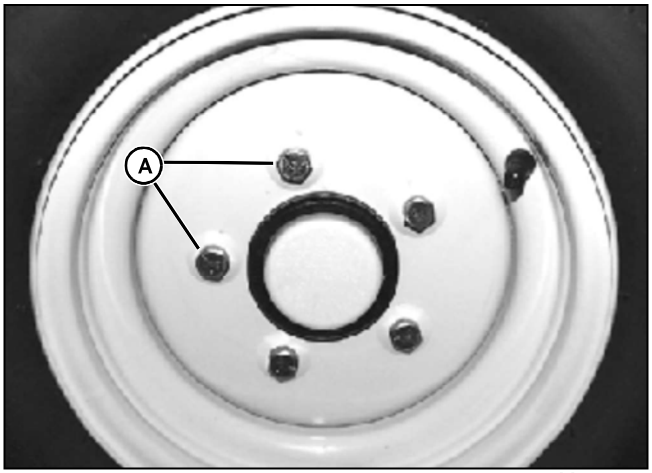
Removal:

1. Remove mower deck. See Mower Deck Removal and Installation for the appropriate mower deck in the Attachments section.

2. Remove fender deck. See “Fender Deck Removal and Installation” on page 590 in the Miscellaneous section.

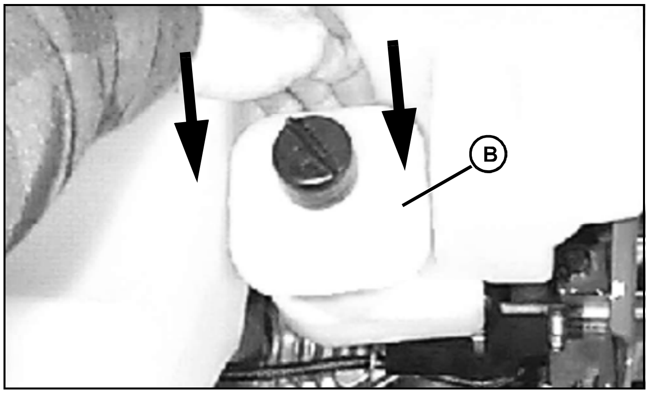
IMPORTANT: Avoid damage! During transaxle removal, rear of machine must be supported by the frame.

3. Raise rear of machine and support on suitable stands.



M99521

4. Remove five bolts (A) securing wheel and remove wheel. Repeat for other side.

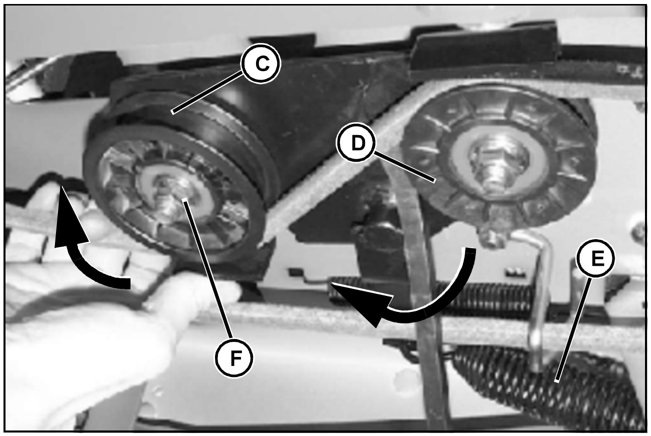


M95320

5. Push hydrostatic transaxle oil reservoir (B) rearward, and disconnect it from the fuel tank.

CAUTION: Avoid injury! Gasoline is extremely flammable. Do not smoke. Always work in a ventilated area away from open flame or spark producing equipment; including equipment that utilizes pilot lights. Wipe-up any spills IMMEDIATELY.

6. Lift and remove fuel tank from machine frame. Set fuel tank aside.

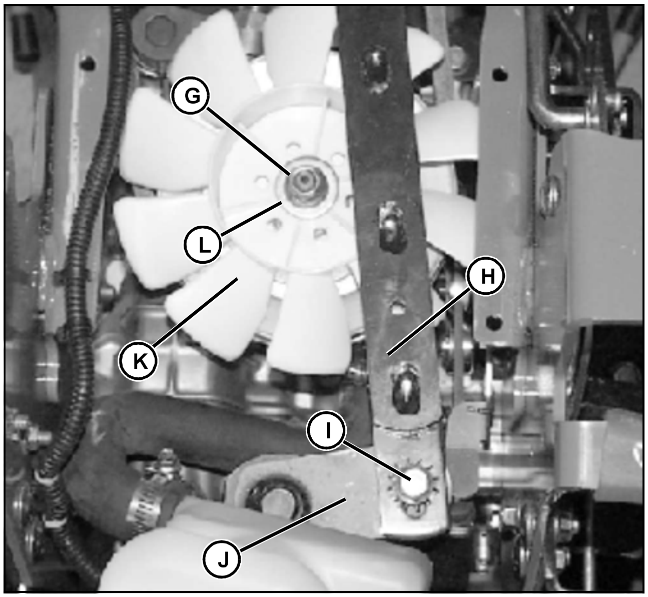


M99618

7. Loosen nut (F) on flat idler (C).

NOTE: If belt will not slip off of flat idler, disconnect tension spring (E) to remove tension on belt.

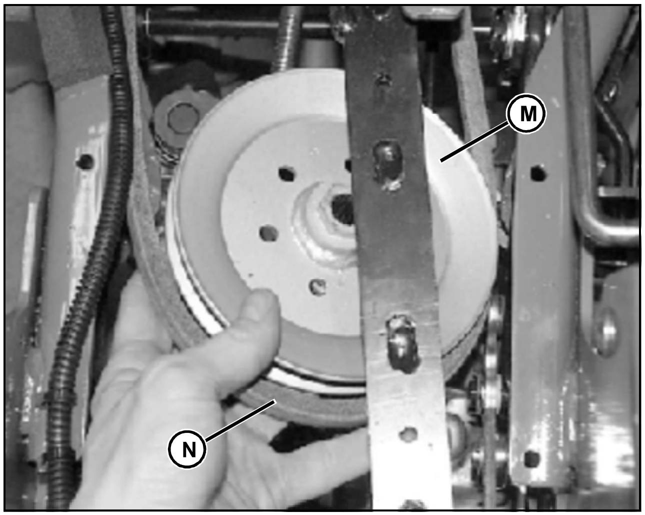
8. Pull belt tensioner assembly against spring (E) tension and slip belt off of flat idler (C) and V-idler (D).



M99681

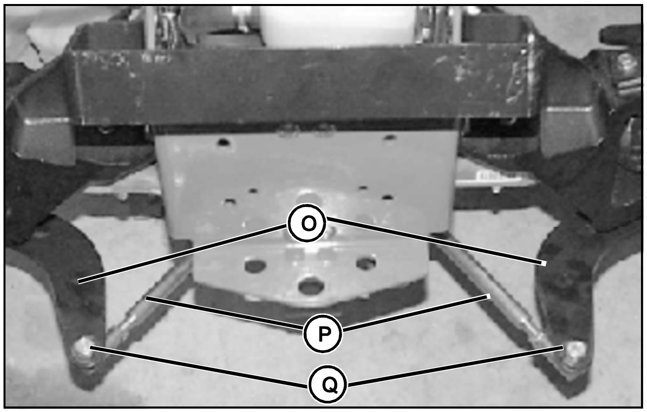
9. Remove cap screw (I), internal/external tooth lock washer, locknut, and spacer. Disconnect control strap (H) from rear pivot (J).

10.Remove locknut (G), washer (L), and transaxle cooling fan (K).



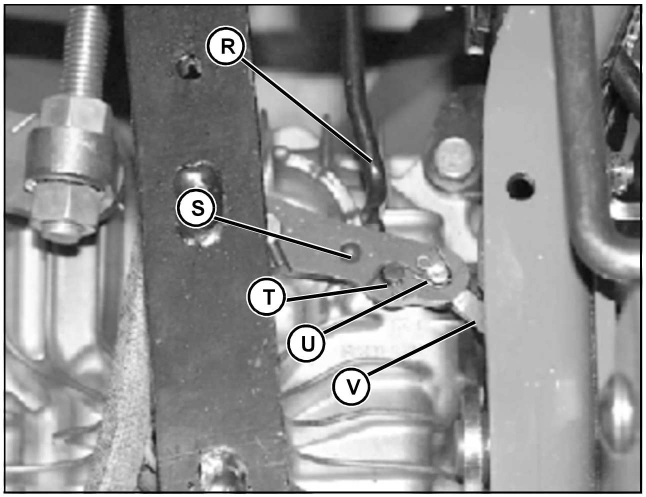
M99682

11.Lift input sheave (M) off top of transaxle. Slip drive belt (N) off of sheave and move aside. Remove sheave.



M99683

12.Remove two locknuts (Q) attaching rear tie rods to spindle arms (O). Disconnect tie rods (P) from spindle arms.



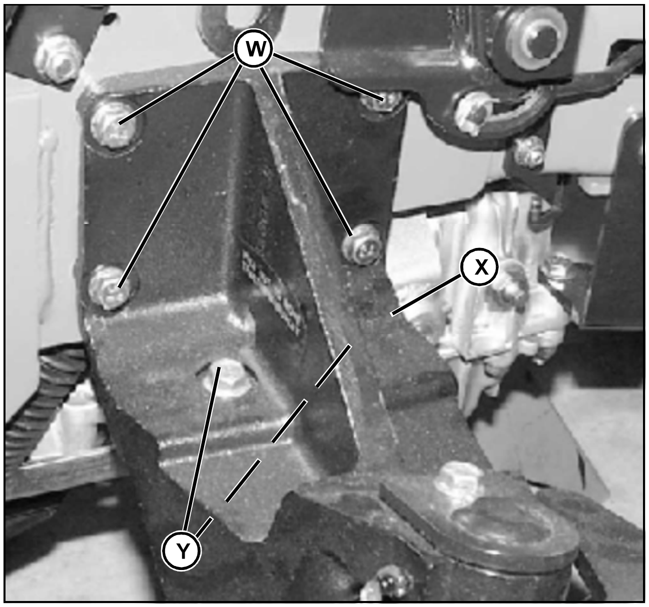
M99687

13.Remove cotter pin (U) attaching freewheeling control rod (V) to transaxle lever (S). Remove rod from lever and right rear axle support.

14.Remove cotter pin (T) attaching freewheeling interlock rod (R) to transaxle lever. Disconnect rod.

15.Support transaxle using a transmission jack.

IMPORTANT: Avoid damage! Transaxle will fall to floor if not adequately supported by a transmission jack or other suitable lifting device. Be sure transaxle is properly supported before removing cap screws and locknuts.



M99685

16.Remove four cap screws and nuts (W) securing right axle support (X) to machine frame.

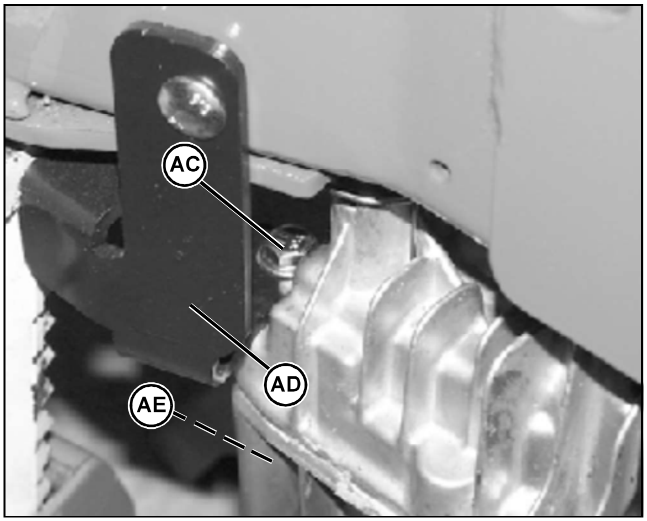
17.Remove two cap screws and locknuts (Y) attaching transaxle to right rear axle support.

18.Remove right axle support, universal joint, and hub from machine as an assembly.

19.Repeat procedure for left axle support assembly.

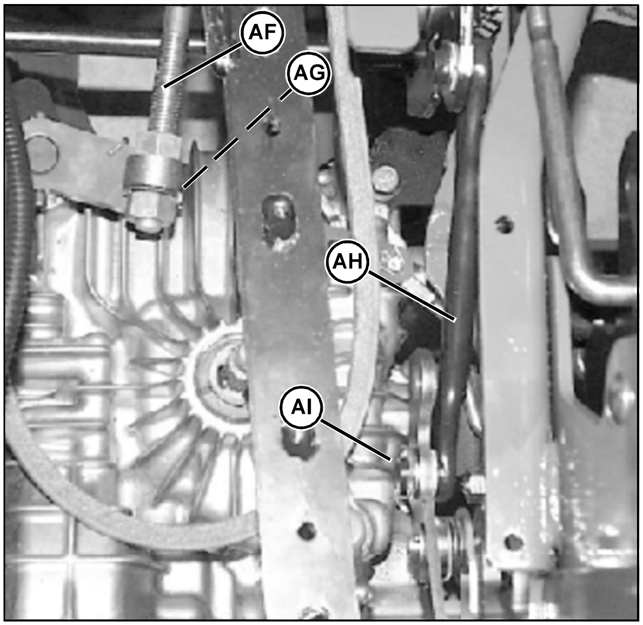
20.Inspect hub carrier, bearings, universal joint, and pivot for wear or damage on both axle assemblies. Replace parts as needed.

21.Remove cap screw (Z) and locknut (AB) attaching right front of transaxle to support bracket (AA).



M99701

22.Remove cap screw (AC) and locknut (AE) attaching left front of transaxle to support bracket (AD).

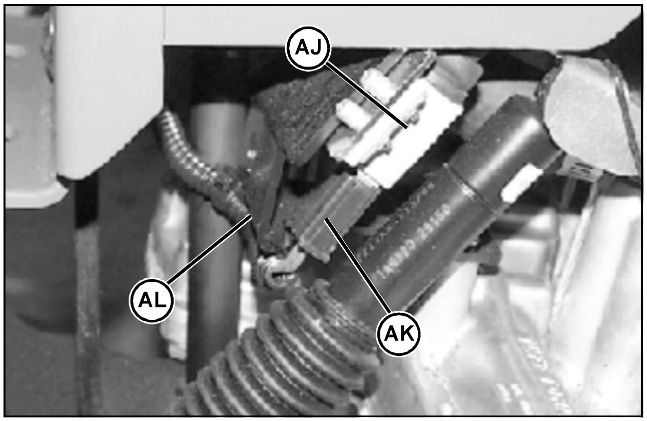


M99688

23.Remove cotter pin and washer (AG) and disconnect brake rod (AF) from transaxle control lever.

24.Remove cotter pin and washer (AI) from forward/reverse control rod (AH).

25.Move transaxle forward, and lower slightly and disconnect forward/reverse control rod from transaxle.



M99689

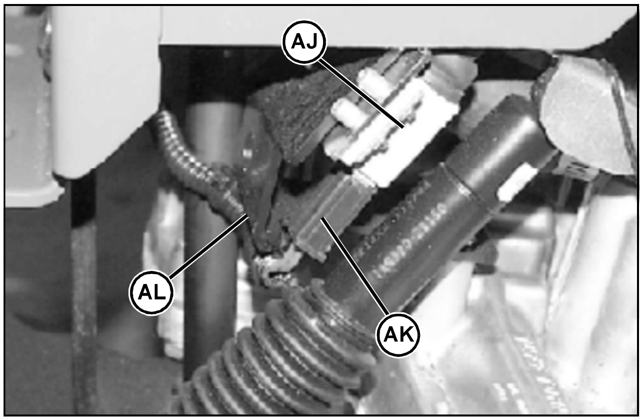
26.Disconnect RIO switch (AJ) wiring harness connector (AK). Disconnect wiring harness clip (AL) from pivot bracket.

IMPORTANT: Avoid damage! Use care when removing transaxle from frame to avoid damage to reservoir and filler tube. It may be necessary to move transaxle forward to clear rear steering pivot assembly.

27.Lower transaxle and remove from machine.

Installation:

1. Place transaxle on a transmission jack, and move into position beneath machine frame.

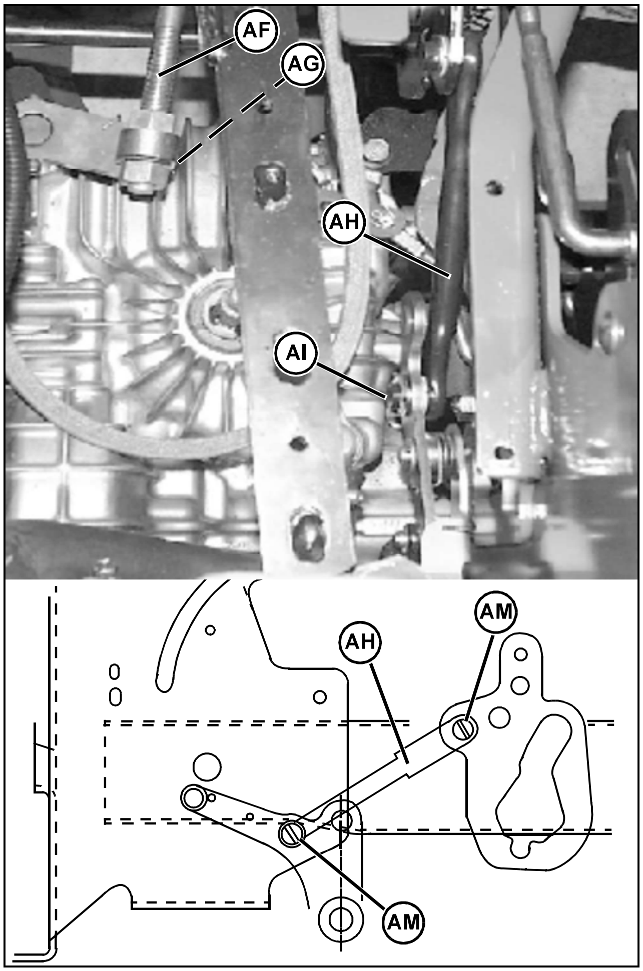


M99689

2. Raise transaxle into position and connect wiring harness RIO switch (AJ) connector (AK) to neutral switch.

3. Attach harness wiring harness clip (AL) to RIO switch bracket.

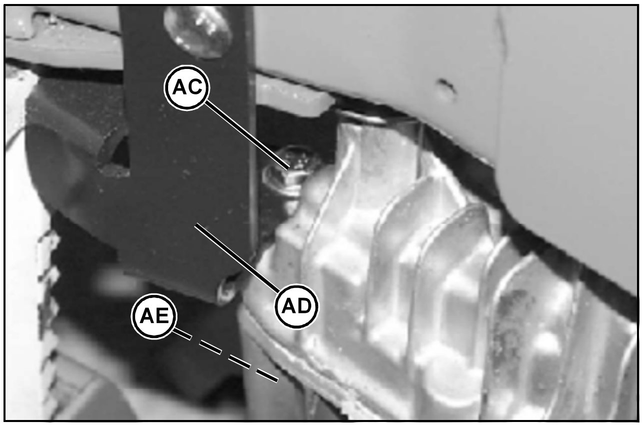
IMPORTANT: Avoid damage! Be sure bushing is in place when attaching forward/reverse control rod (AH) to transaxle. Also, pay particular attention to holes (AM) control rod is placed in. Damage may occur if wrong holes are used.



M99688/MIF

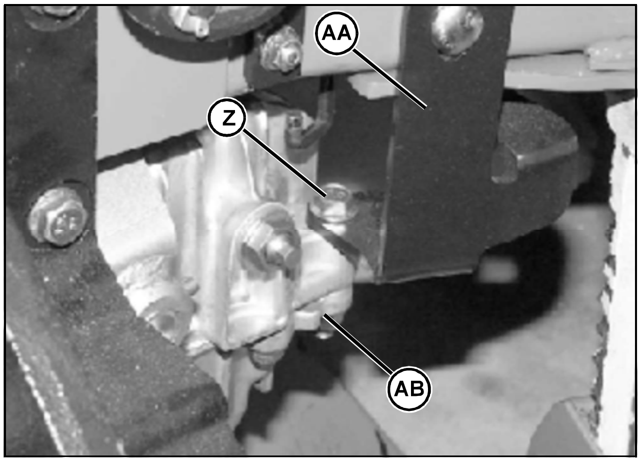
4. Move transaxle rearward, and raise slightly. Connect forward/reverse control rod (AH) to transaxle. Retain with washer and cotter pin (AI).

5. Connect brake rod (AF) to transaxle control lever. Retain with washer and cotter pin (AG).



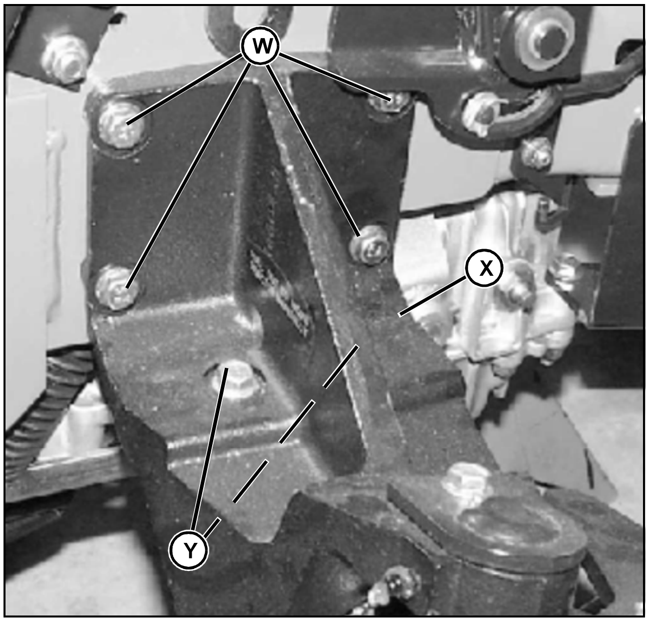
M99701

6. Raise transaxle into position and install cap screw (AC) and locknut (AE) to attach left front of transaxle to support bracket (AD).



M99684

7. Install cap screw (Z) and locknut (AB) to attach right front of transaxle to support bracket (AA).



M99685

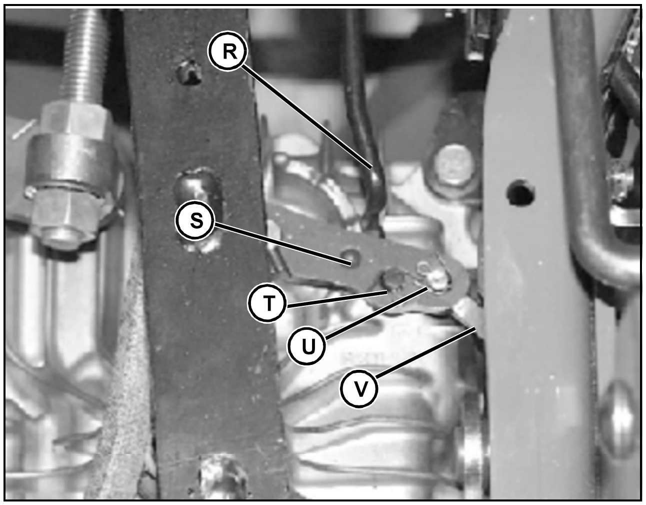
8. Apply a small amount of grease to axle shaft splines.

9. Install right axle support (X), universal joint, and hub to machine as an assembly.

10.Install two cap screws and locknuts (Y) to attach transaxle to right rear axle support.

11.Install four cap screws and nuts (W) to secure right axle support to machine frame.

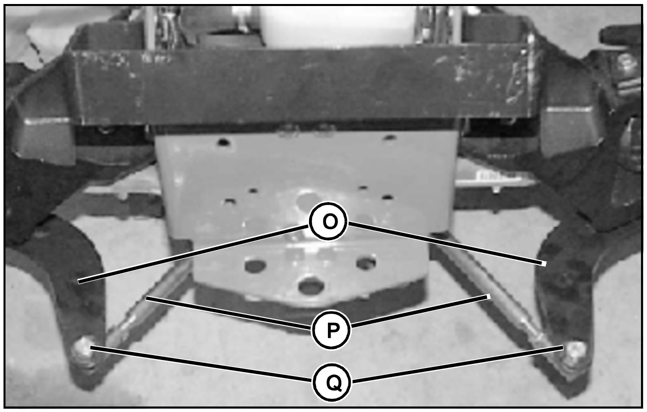
12.Repeat procedure for left axle support assembly.



M99687

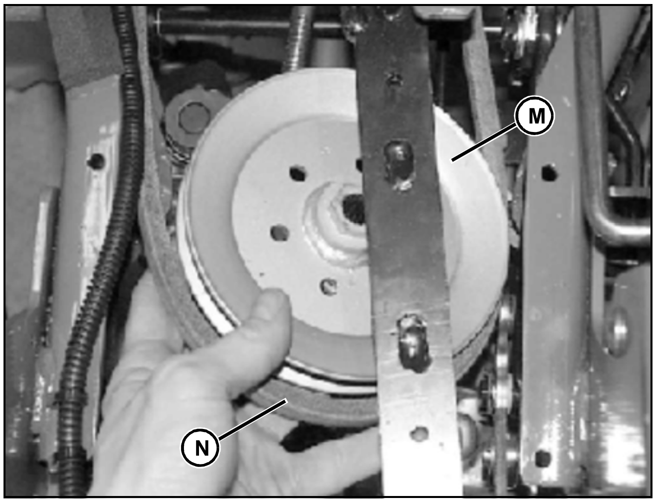
13.Install freewheeling control rod (V) through right rear axle support. Attach to transaxle control lever (S) and retain with cotter pin (U).

14.Attach freewheeling interlock rod (R) to transaxle lever (S). Retain with cotter pin (T).



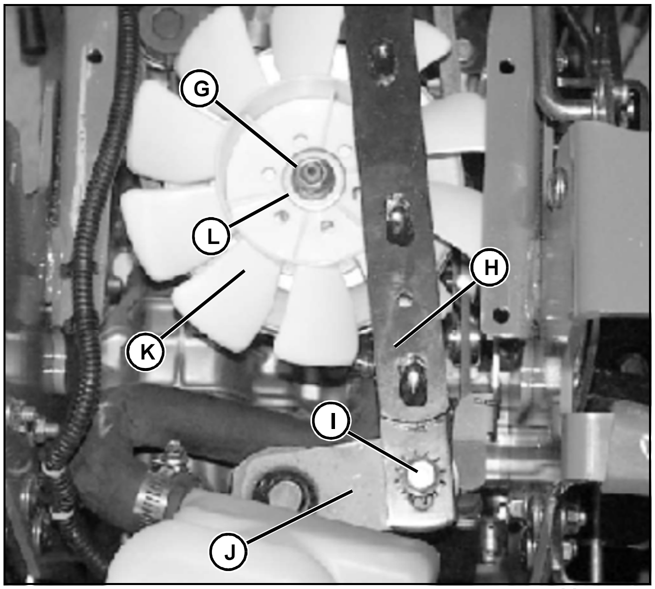
M99683

15.Connect tie rods (P) to rear spindle arms (O). Retain with two locknuts (Q). Tighten nuts to 60 N•m (44 lb-ft).



M99682

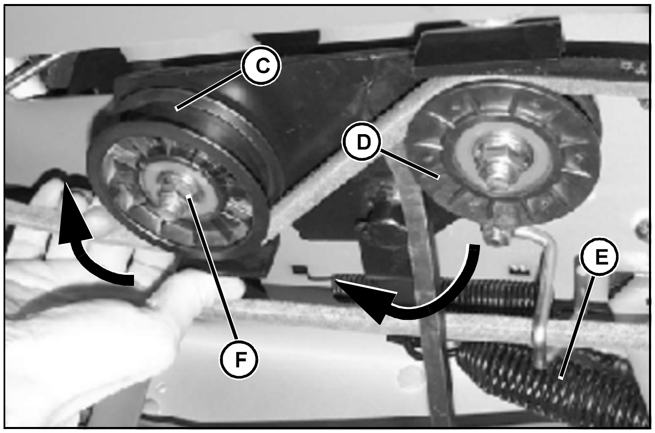
16.Slip traction drive belt (N) onto input sheave (M). Install input sheave to shaft on top of transaxle.



M99681

17.Install transaxle cooling fan (K) to input shaft. Retain with washer (L) and locknut (G). Tighten locknut to 30 N•m (22 lb-ft).

18.Install cap screw (I), locknut, spacer, and internal/external tooth lock washer to attach control strap (H) to rear pivot (J). Do not tighten at this time.



M99618

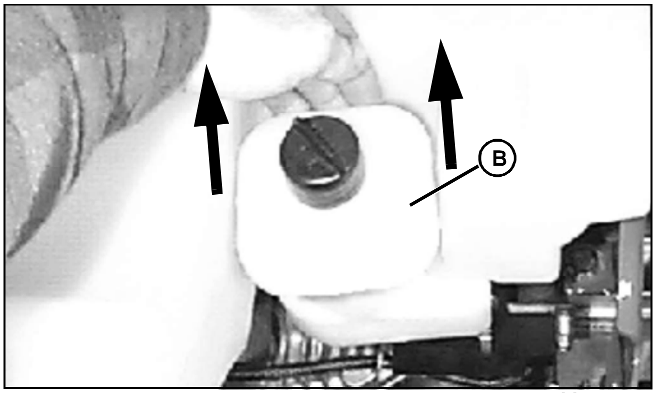
19.Check traction drive belt to make sure it is properly seated in engine drive sheave and transaxle input sheave grooves. Check that belt is properly seated in grooves of two stationary idler sheaves.

20.Pull belt tensioner assembly against spring (E) tension and slip belt onto flat idler (C) and V-idler (D).

21.Tighten nut (F) on flat idler.

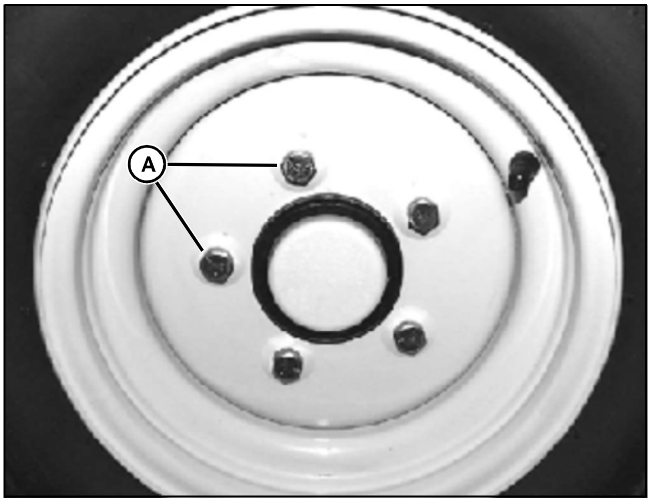
CAUTION: Avoid injury! Gasoline is extremely flammable. Do not smoke. Always work in a ventilated area away from open flame or spark producing equipment; including equipment that utilizes pilot lights. Wipe-up any spills IMMEDIATELY.

22.Install fuel tank to machine frame.



M95320

23.Push hydrostatic transaxle oil reservoir (B) forward, and connect it to the fuel tank.



M99521

24.Install wheel. Retain with five bolts (A). Tighten bolts to 55 N•m (41 lb-ft). Repeat for other side.

25.Raise rear of machine, remove stands, and lower machine to the ground.

26.Perform rear wheel alignment procedure. See "Rear Wheel Alignment - AWS" on page 473 in the Steering section.

27.Install fender deck. See "Fender Deck Removal and Installation" on page 590 in the Miscellaneous section.

28.Perform transaxle bleeding procedure See "Hydrostatic Transaxle Bleeding Procedure" on page 407.

29.Start engine, unlock park brake and drive machine forward and backward.

30.Check for oil leaks.

31.Park machine on a level surface. Stop engine and check oil level in reservoir bottle. Add oil if needed to bring level up to FULL line.

32.Start engine and release park brake. If machine moves with engine running and hydrostatic control in neutral, perform neutral creep adjustment. See "Neutral Creep Adjustment" on page 407.

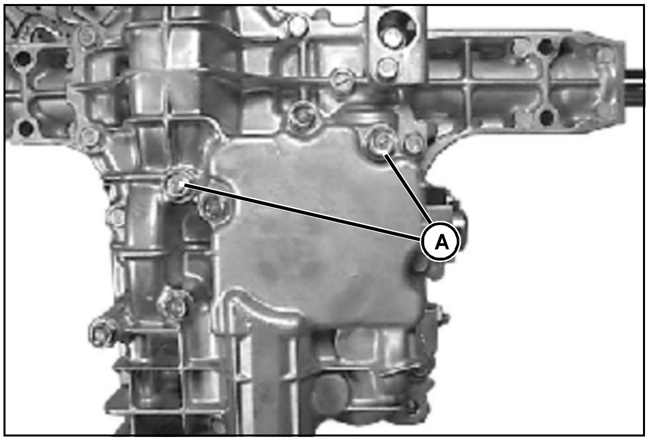
33.Install mower deck. See Mower Deck Removal and Installation for the appropriate mower deck in the Attachments section.

Transaxle Disassembly

Procedure:

1. Remove transaxle from machine. See "Transaxle Removal and Installation - 2WS Models" on page 411 or "Transaxle Removal and Installation - AWS Models" on page 418.
2. Thoroughly clean outside surface of transaxle.

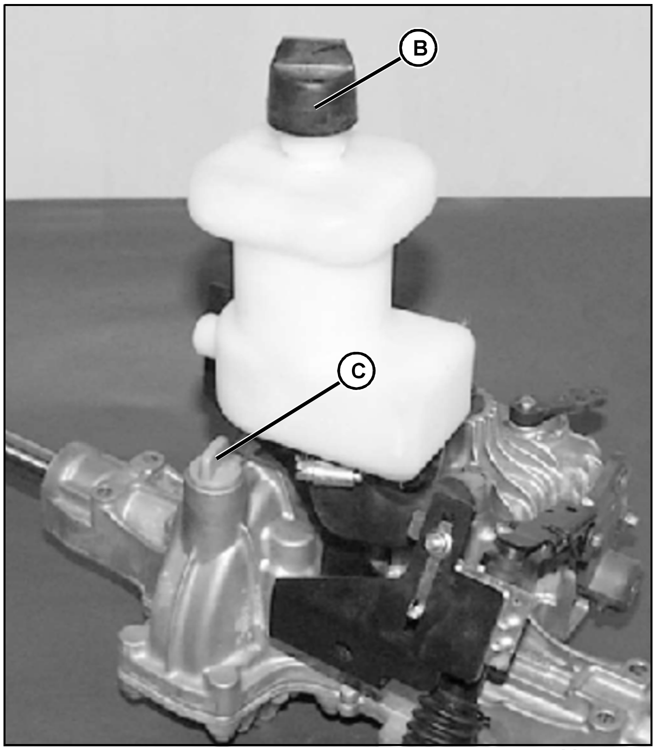
NOTE: Capacity of the transaxle is approximately 2.5 L (2.65 qt). Have a suitable container ready before removing drain plugs.



M94895

3. Remove two drain bolts (A) on bottom of transaxle. Drain transaxle oil into a suitable container.

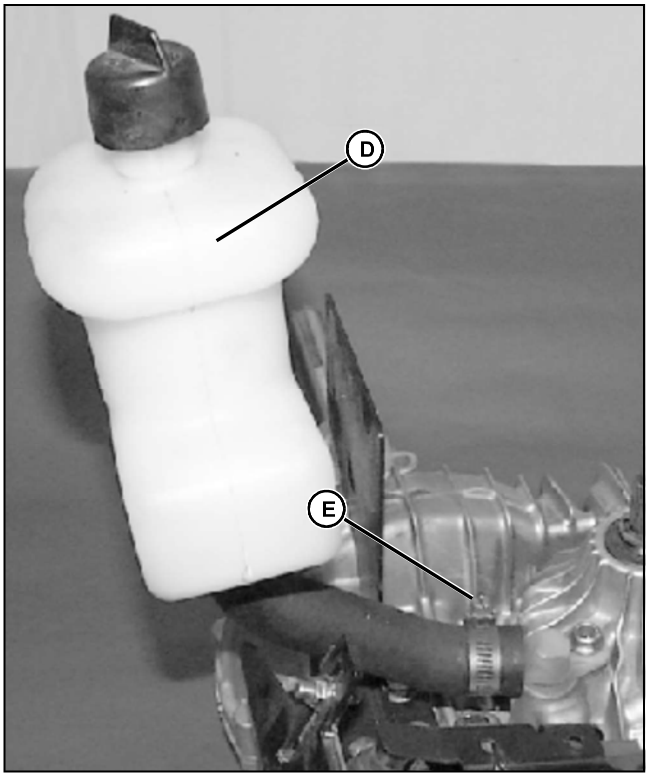
NOTE: Replace two seal washers on drain bolts before installing.



M99633

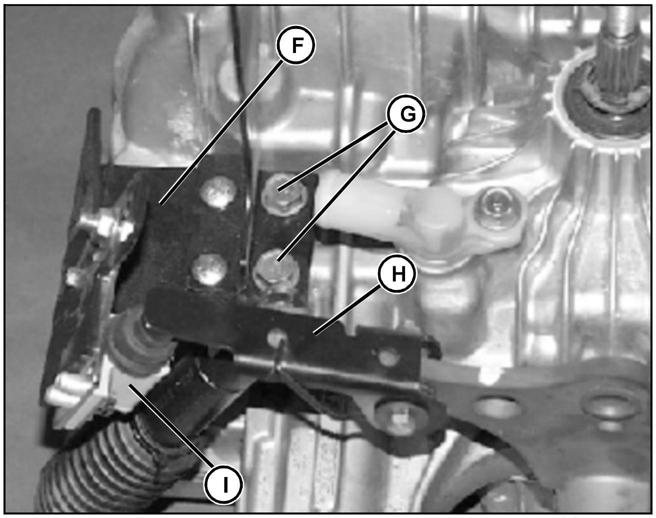
Picture Note: 2WS Shown

4. Loosen fill cap (B) on reservoir bottle, and fill plug (C) on transmission case to allow air to enter the transmission case and speed oil drainage.



M99632

5. Loosen clamp (E) and remove reservoir bottle (D).

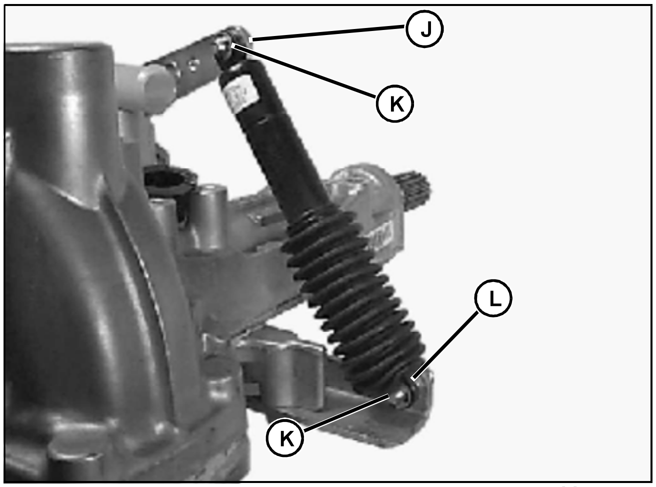


M99634

Picture Note: 2WS Shown

6. Remove two cap screws (G) and neutral switch (I) bracket (F).

7. Inspect neutral switch lever assembly (H) for wear or damage. Replace parts as needed.

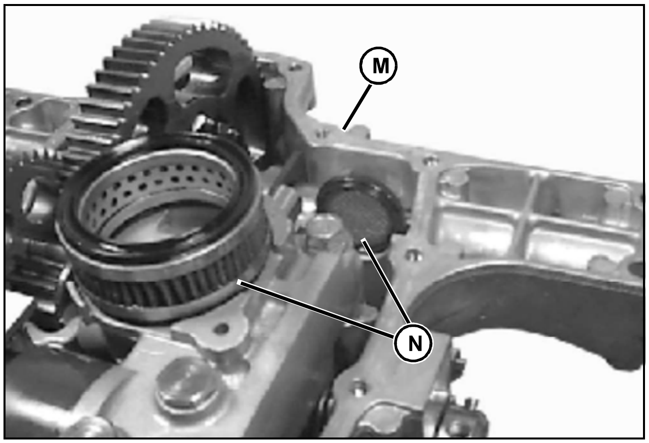


M94896

8. Remove 2 E-clips (K) from shock absorber, and remove shock absorber, collar (L), and pin (J) from transaxle.

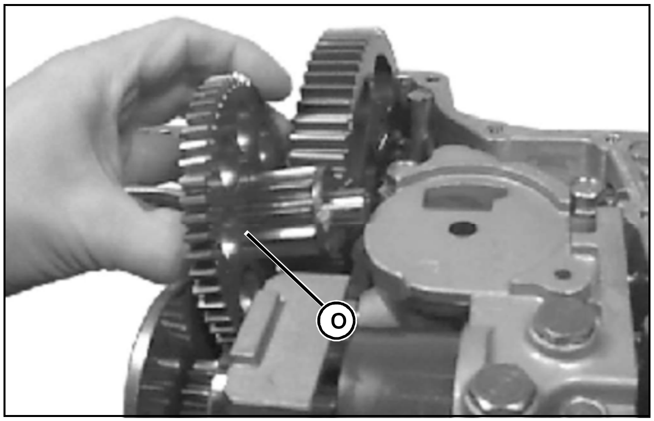
9. Turn transaxle over and support it with blocks.

10.Remove five bolts and 12 screws securing lower case to upper case. Remove lower case from transaxle.



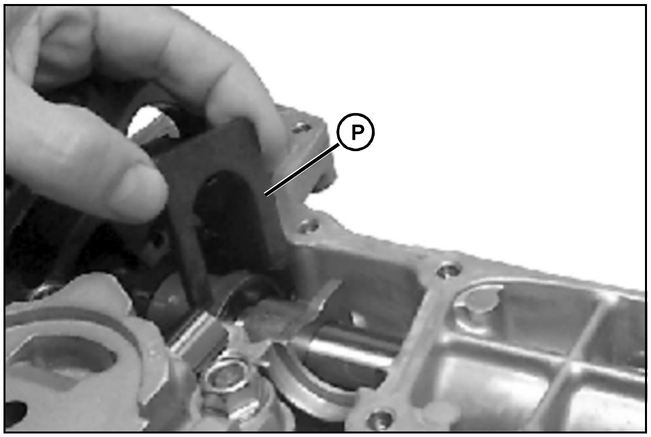
M94897

11.Remove oil filters (N) from transaxle case (M). Inspect oil filters and replace if needed.



M94898

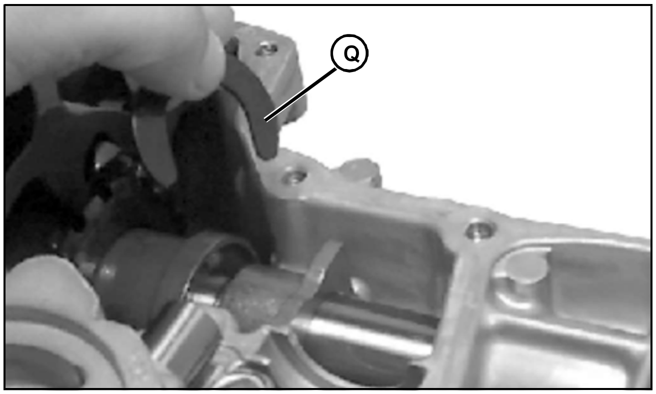
12.Remove reduction gear assembly (O) from upper case.



M94899

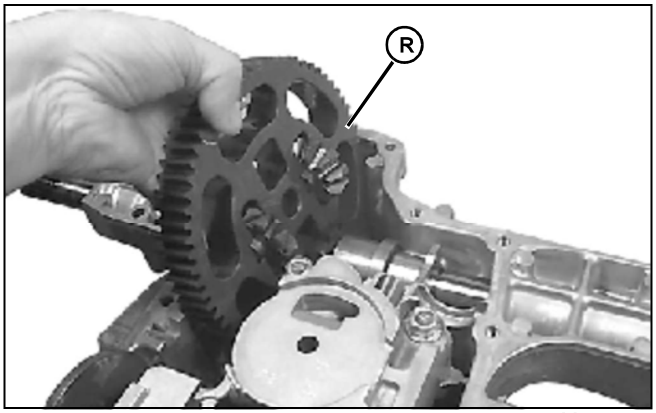
13.Remove thrust washer (P) from left hand and right hand axles.

NOTE: To remove the C-rings (Q), pull the axles slightly out of the case.



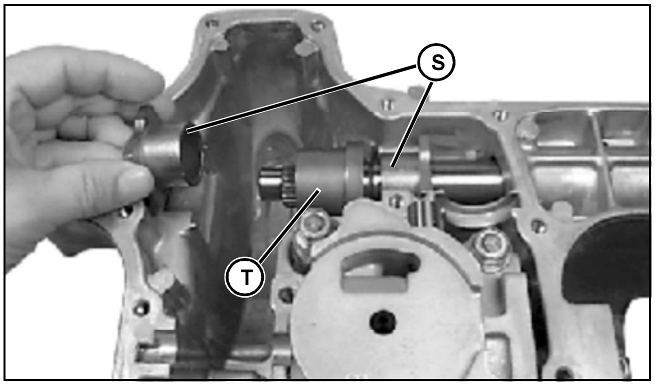
M94908

14.Remove C-ring (Q) from left hand and right hand axles.



M94909

15.Remove differential gear assembly (R).



M94910

16.Remove both axle shafts, collar (T), and bushings (S).

17.Measure OD of both axle shafts. If axle is smaller than specification, replace axle.

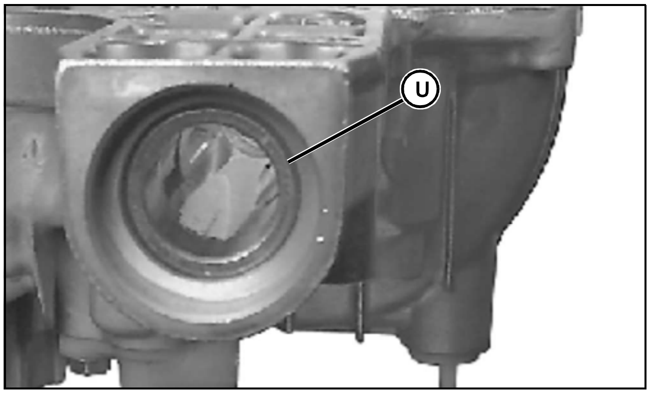
18.Measure ID of bushings. If bushing(s) ID is larger than specification, replace bushing(s).

Specifications:

Bushing ID	**25.381 - 25.525 mm (0.999 - 1.005 in.)**
Axle OD	**25.301 - 25.355 mm (0.996 - 0.998 in.)**
Clearance (maximum)	**0.5 mm (0.020 in.)**

NOTE: Replace axle shaft seals with new seals when assembling transaxle.

19.Remove the two axle seals from upper case. Measure ID of bushings press fit into case.

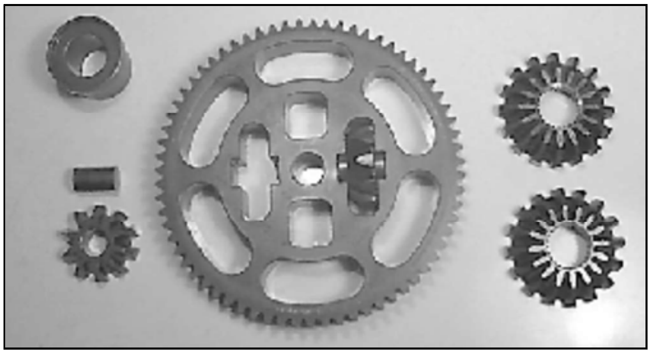


M94911

20.If bushing(s) (U) ID measurement is larger than specification, replace bushing(s).

Specification:

Bushing ID. . . . . . 25.505 - 25.585 mm (1.004 - 1.007 in.)



M94912

21.Inspect differential gear assembly for wear or damage. Replace as needed.

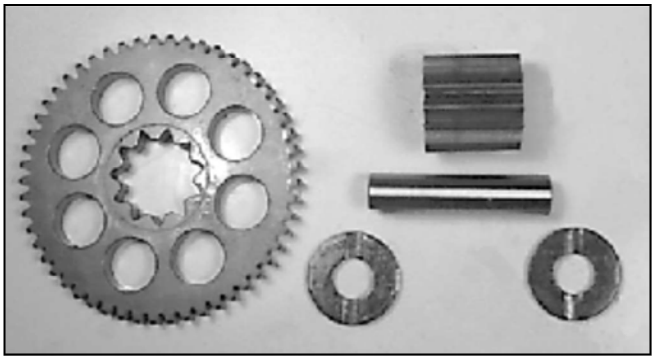
22.Measure ID of differential pinion gears and OD of differential pinion shaft. Replace if measurements do not meet specifications.

Specifications:

Pinion Gear ID. . . . . 15.03 - 15.13 mm (0.592 - 0.597 in.)

Pinion Shaft OD . 14.904 - 14.984 mm (0.587 - 0.590 in.)

Clearance (maximum) . . . . 0.5 mm (0.020 in.)



M94934

23.Inspect reduction gear assembly for wear or damage. Replace as needed.

24.Measure ID of reduction pinion gear and OD of reduction shaft. Replace shaft and/or gear if measurements do not meet specifications.

Specifications:

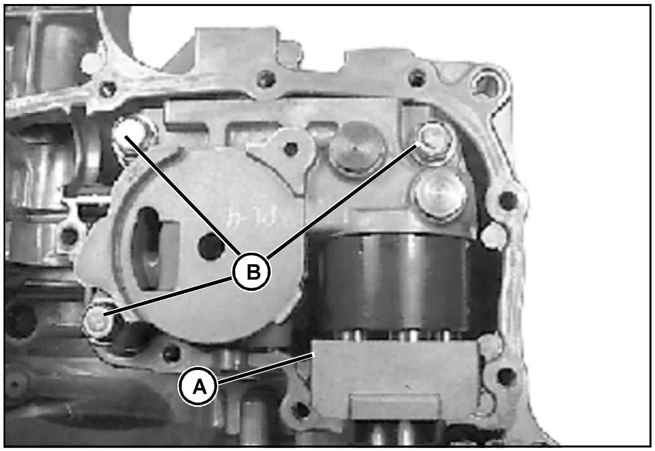
Reduction Pinion Gear ID . . . . 15.044 - 15.174 mm (0.592 - 0.597 in.)

Reduction Shaft OD . . . . 14.954 - 14.984 mm (0.589 - 0.560 in.)

Clearance (maximum) . . . . 0.5 mm (0.020 in.)

Center Case Removal

Procedure:

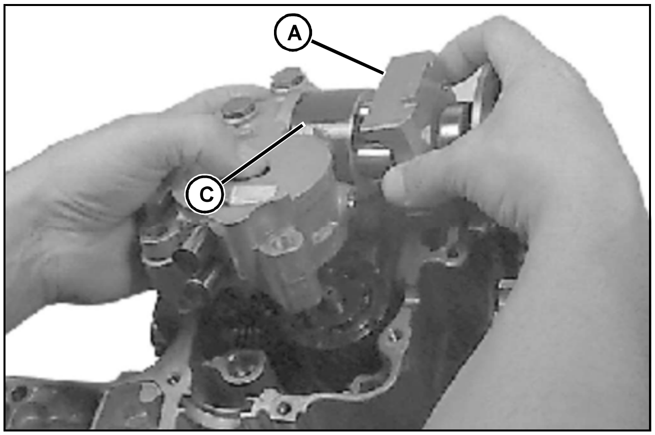


M94913

1. Before removing center case assembly, note position and orientation of swash plate (A).

2. Remove three cap screws (B) securing center case assembly to transaxle case.

IMPORTANT: Avoid damage! When removing center case assembly, be careful to avoid scratching or damaging contact surfaces of center case and cylinder blocks.

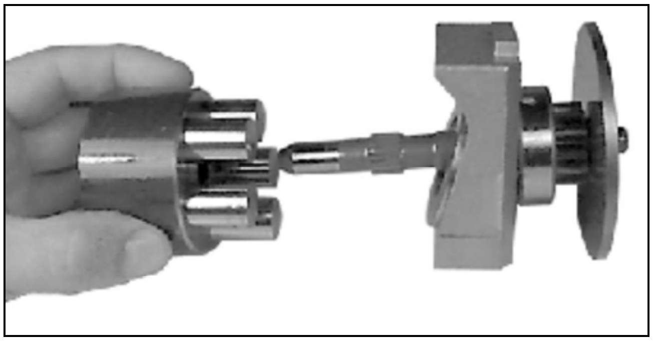


M94914

3. Press brake disk, swash plate (A) and cylinder block (C) against the center case and remove as a single unit. Set assembly on a clean lint free cloth or surface.

NOTE: When separating cylinder block from center case a small pin and a washer may fall out.

4. Separate cylinder block from center case.



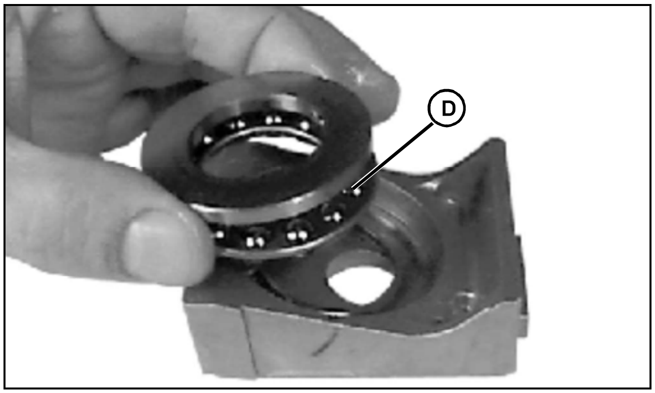
M94916

5. Slide cylinder block off of brake shaft.

6. Remove pistons and inspect springs and piston holes for wear or damage. Inspect cylinder block mating surface for damage or scratches.

NOTE: If any parts of the cylinder block assembly need to be replaced, replace center case and both cylinder blocks at the same time.

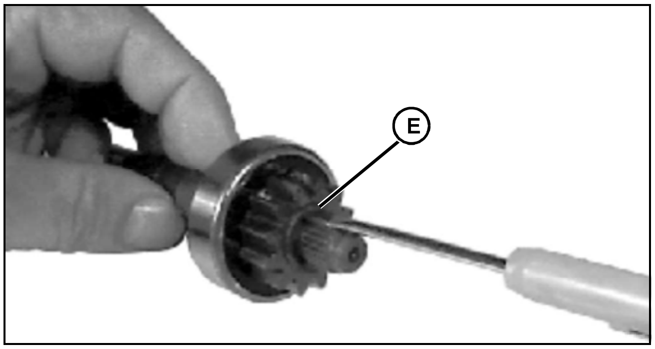
7. Remove brake disk and shaft from swash plate.



M94917

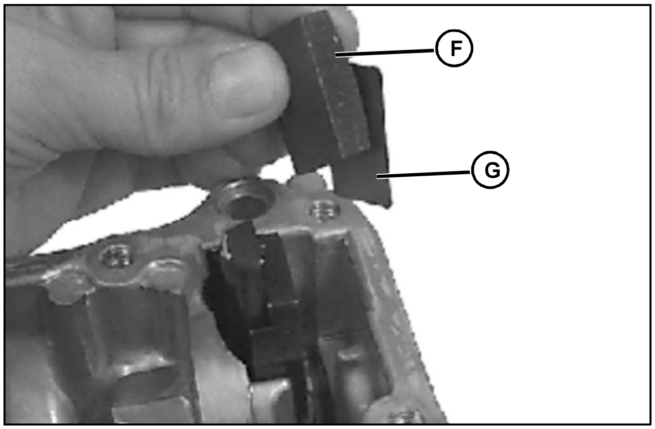
8. Inspect swash plate and thrust bearing (D) for wear or damage. Check that all ball bearings move freely and that swash plate and housing bearing contact surfaces are in good condition.

9. Inspect brake shaft bearing for wear or damage. Replace as needed.



M94918

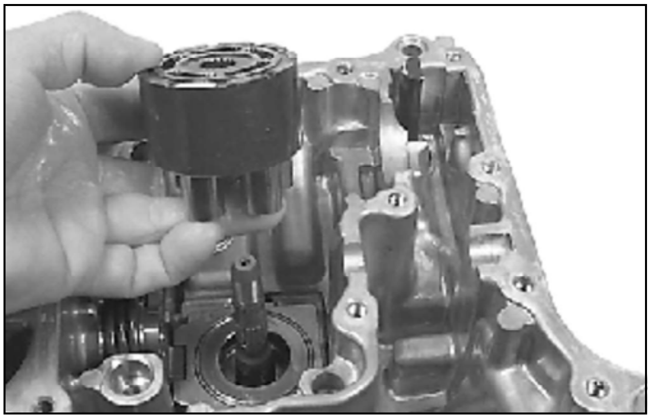
10.To remove brake shaft bearing:
- Remove C-clips (E) securing gear and bearing
- Remove gear and bearing



M94915

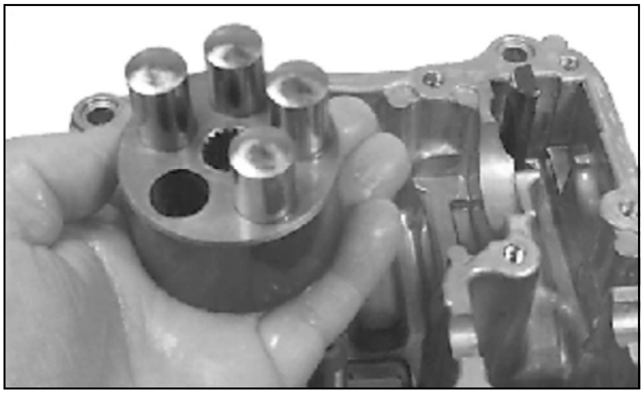
11.Remove outer brake shoe (F) and shim (G) from case. Note that convex side of brake shoe faces shim and outer side of case.

NOTE: When removing the cylinder block, be careful to not let the pistons fall out.



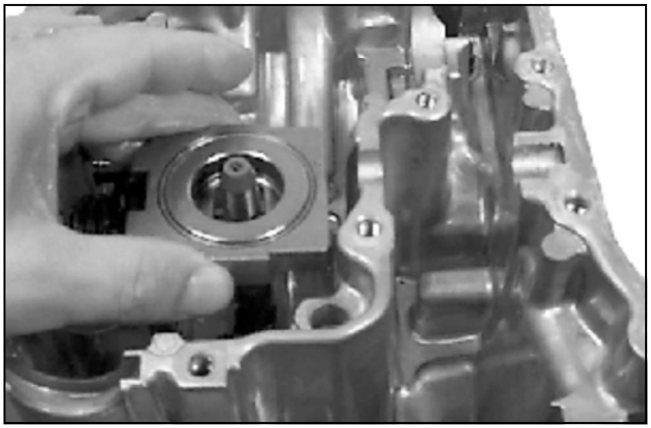
M94919

12.Remove the cylinder block from upper case.



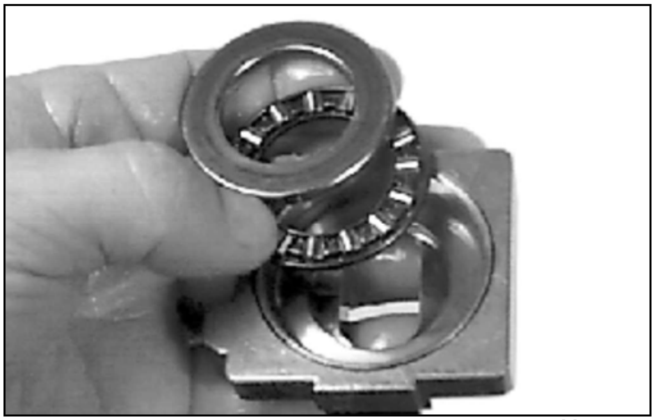
M94920

13.Remove pistons and inspect springs and piston holes for wear or damage. Inspect cylinder block mating surface for damage or scratches.



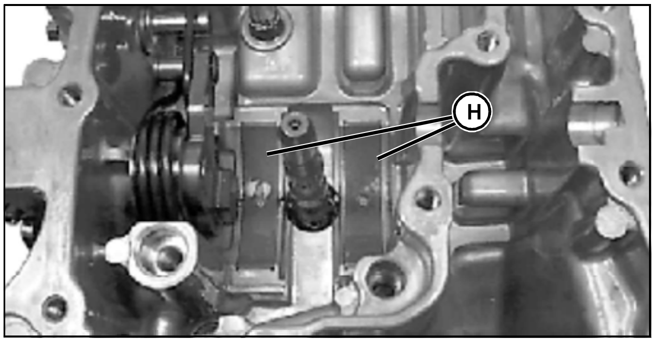
M94921

14.Remove swash plate sub assembly from upper case.



M94922

15.Inspect swash plate, thrust bearing, thrust plate and bushing for wear or damage. Replace as needed.



M94923

16.Remove thrust plates (H). Inspect plates for wear or damage. Measure thrust plate thickness. Replace thrust plates as a set if either one or both do not meet specification.

Specification:

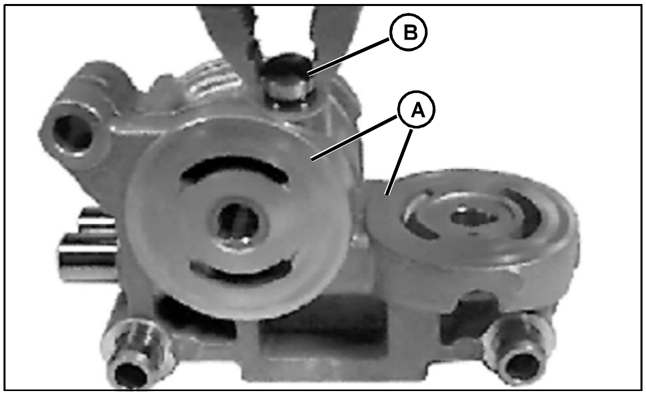
Thrust Plate

Thickness . . . . 1.45 - 1.55 mm (0.057 - 0.061 in.)

Wear Limit. . . . . 1.30 mm (0.051 in.)

Center Case Disassembly

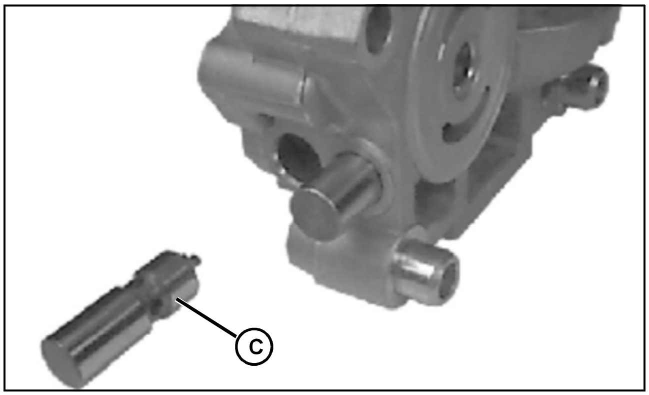
Procedure:



M94937

1. Inspect center case motor surfaces (A). If scratches can be detected by feel (either finger nail or lead pencil), replace center case and motor cylinders at the same time.

2. Remove plug (B) from center case. Inspect O-ring for scratches or deformation. Lubricate plug with clean oil and reinstall.



M94938

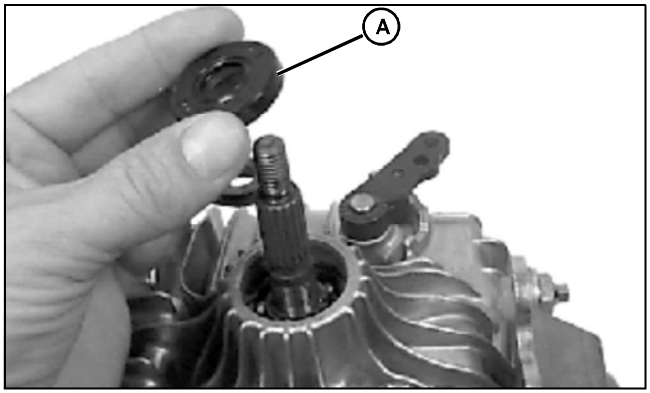
3. Remove valve assemblies (C) from center case and inspect surfaces for wear or scratches.

Pump Shaft Removal

Procedure:

1. Turn the upper case over and inspect the pump shaft and shaft seal.

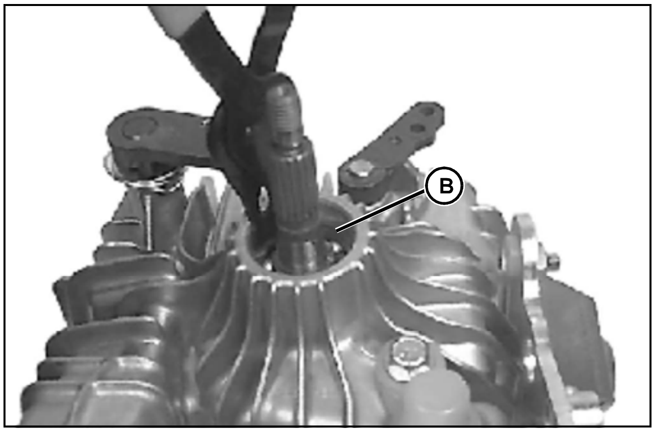
NOTE: If the shaft turns freely and the oil seal is not leaking there is no need to remove the pump shaft.



M94924

2. Pry out and remove oil seal (A) from pump shaft.

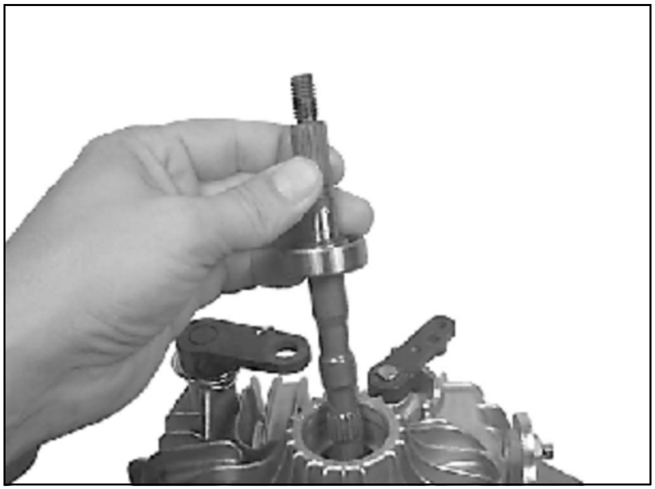
NOTE: Replace seal for installation.



M94925

Picture Note: K62B Shown

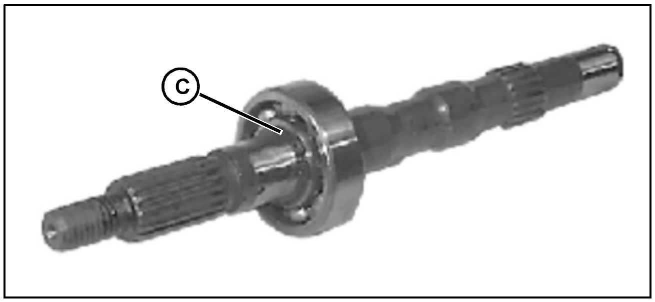
3. Remove snap ring (B) from case.



M94925

Picture Note: K62B Shown

4. Remove pump shaft and bearing assembly from case.



M94926

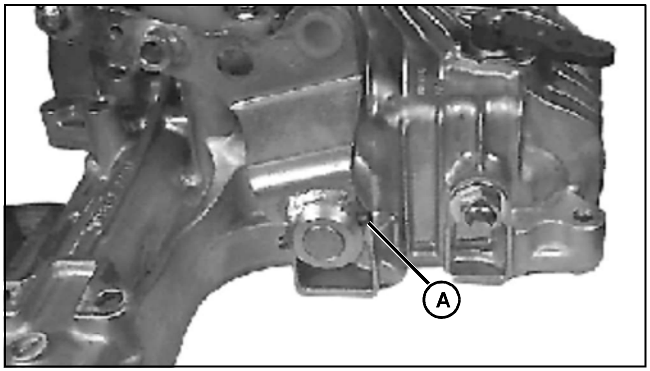
5. Remove snap ring (C) from each side of bearing and press bearing off of shaft.

NOTE: Before installation, lightly coat oil seal with clean fresh transmission oil.

Installation is done in the reverse order of removal.

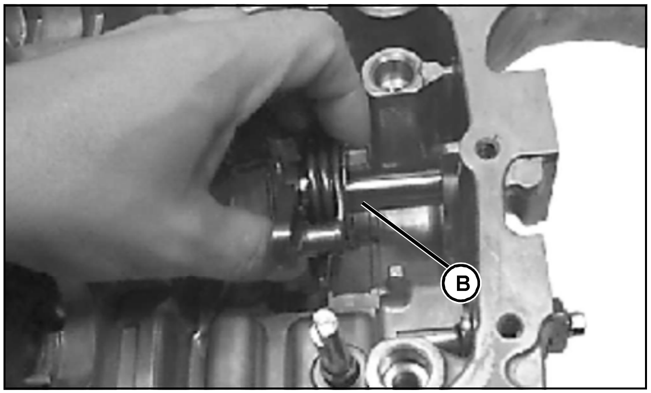
Control Shaft Removal

Procedure:



M94928

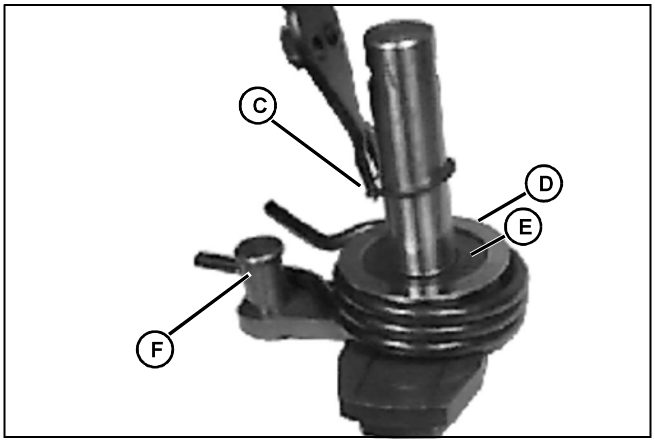
1. Remove roll pin (A) from control arm, and remove control arm from control shaft.



M94929

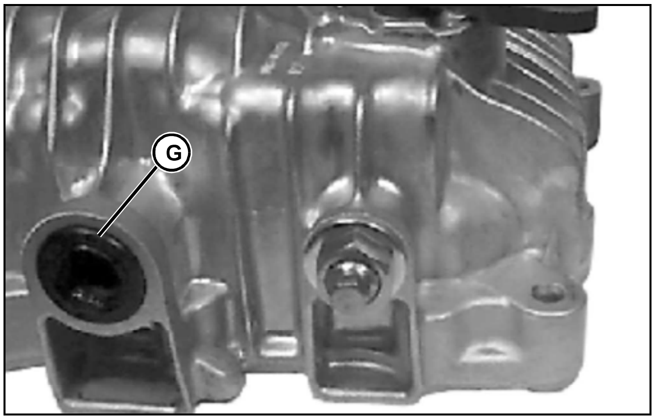
2. Turn the case over and slide the control arm assembly (B) out of case.

3. To remove spring from assembly, firmly clamp the end of the torsion spring (closest to arm) in a bench vise. Firmly clamp the other end of the spring with a locking vise pliers and lift end over control arm pin (F).



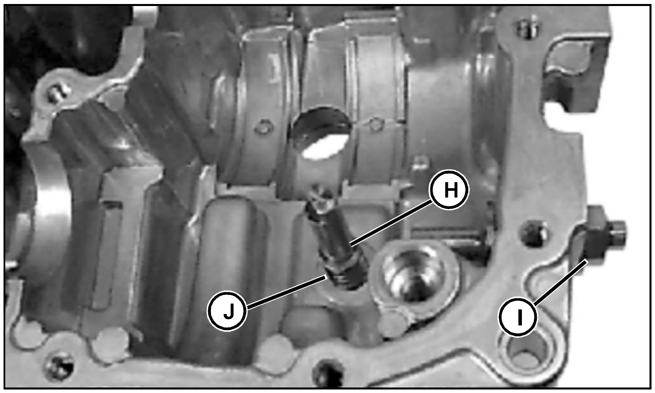
M94930

4. Remove snap ring (C) from control shaft. Remove washer (D), collar (E) and torsion spring.



M94931

5. Replace control shaft seal (G) before installation of control arm assembly.

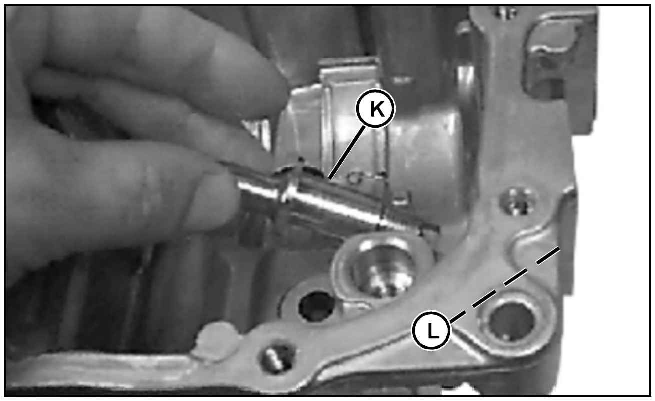


M94933

6. Remove snap ring (H) from by-pass shaft. Remove spring (J). Remove by-pass shaft from case.

7. Inspect by-pass shaft O-rings for scratches or deformation. Replace as needed.

8. Remove nut (I) securing fulcrum. Remove washer.



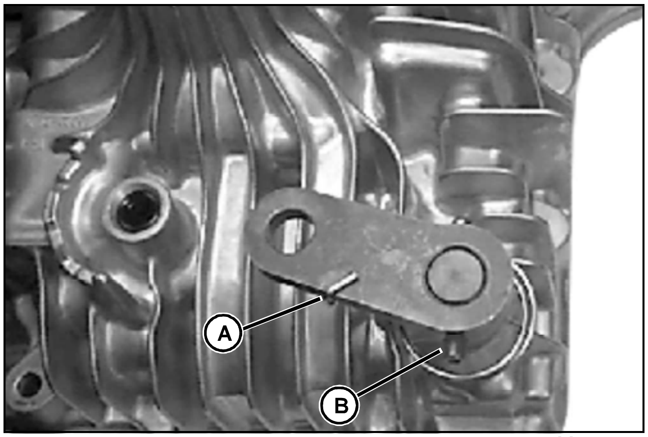
9. Remove fulcrum (K) from case and inspect. Remove O-rings (L) from case.

NOTE: Before installation, lightly coat control shaft seal and O-rings with grease. Lightly coat all other parts with clean fresh transmission oil.

Brake Shaft Removal

Procedure:

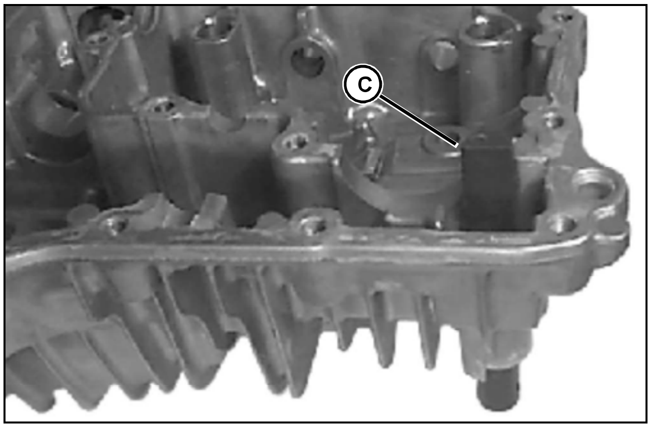
NOTE: Brake arm for K62B is secured to the brake shaft toward the center of the transaxle. The brake arm on the K62A is secured to the brake shaft 180° (away from the center of the transaxle).



Picture Note: K62B Shown

1. Disconnect spring (A) from brake arm.

2. Drive roll pin (B) out of brake arm and shaft. Remove brake arm



3. Turn case over and note position of flat side (C) of brake shaft.

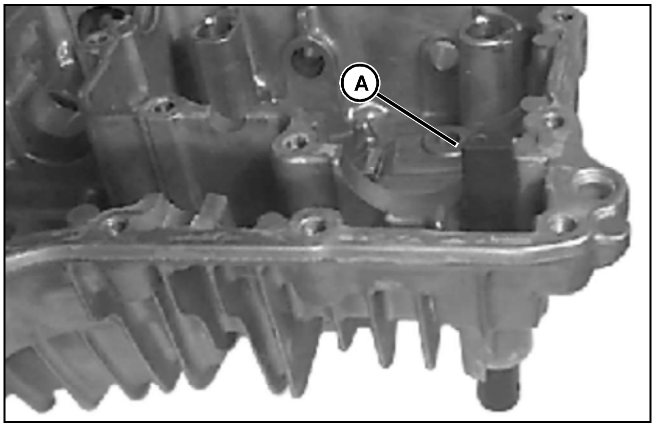
4. Remove brake shaft from case.

Transaxle Assembly

Procedure:

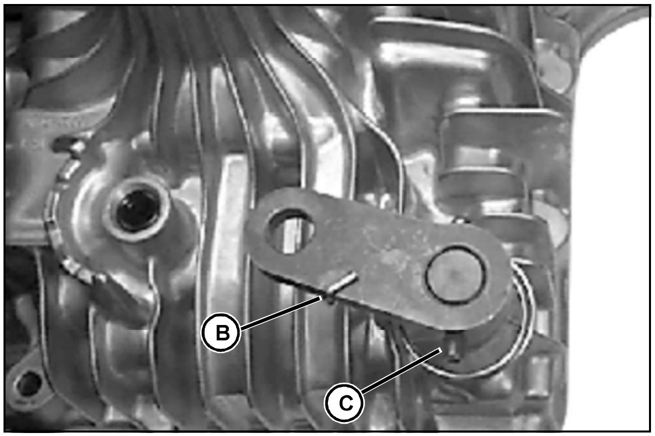
1. During assembly, coat all parts with clean fresh oil.

2. Clean case half mating surfaces of any old sealant. Clean case halves with a suitable solvent and dry with compressed air.



3. Apply a light coat of grease to the brake shaft hole in the upper case. Install brake shaft. Position flat side (A) of brake shaft to case.

4. Install washer and snap ring to brake shaft.



M94935

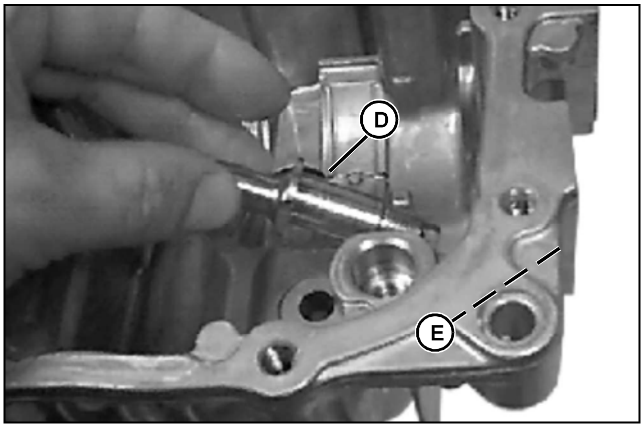
Picture Note: K62B Shown

5. Lightly coat a new O-ring with grease and install on brake shaft.

NOTE: Brake arm for K62B is secured to the brake shaft toward the center of the transaxle. The brake arm on the K62A is secured to the brake shaft 180° (away from the center of the transaxle).

6. Install roll pin (C) through brake arm and shaft.

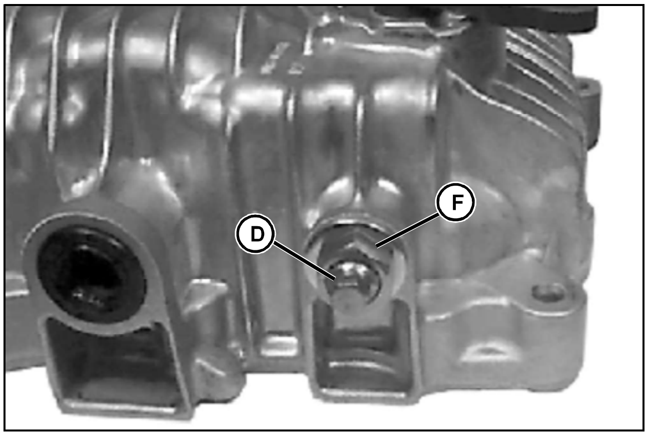
7. Install spring (B).



M94932

8. Apply a light coat of grease to the fulcrum (D) and install in case.

9. Lightly coat a new O-rings (E) with grease and install on fulcrum.



M94931

10. Install washer and nut on fulcrum (D).

11. While holding the fulcrum with a wrench, tighten nut (F) to specification.

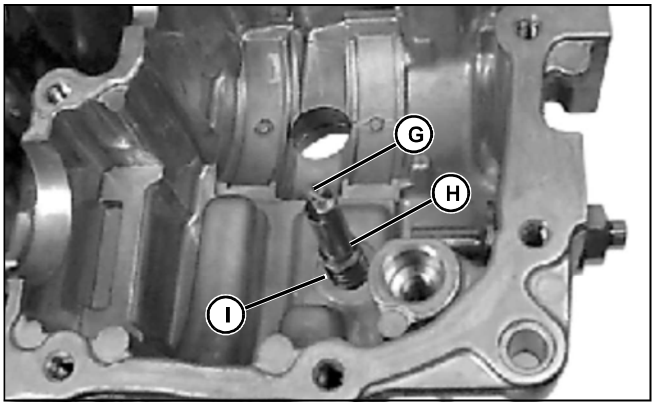
Specification:

Fulcrum Nut Torque . . . . 24.5 - 32 N•m (18 - 24 lb-ft)

12. If removed, install by-pass arm on by-pass shaft and secure with roll pin.

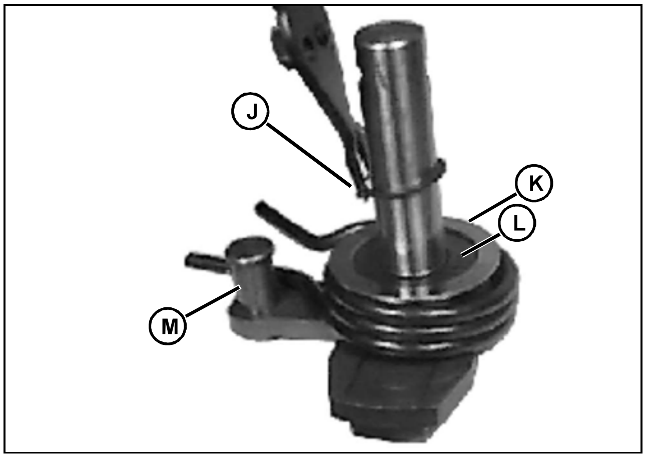
13. Lightly grease new O-rings and install on by-pass shaft.

14. Apply a light coat of grease to the by-pass shaft hole in the upper case. Install by-pass shaft.



M94933

15. Place spring (I) on by-pass shaft (G). Install snap ring (H).

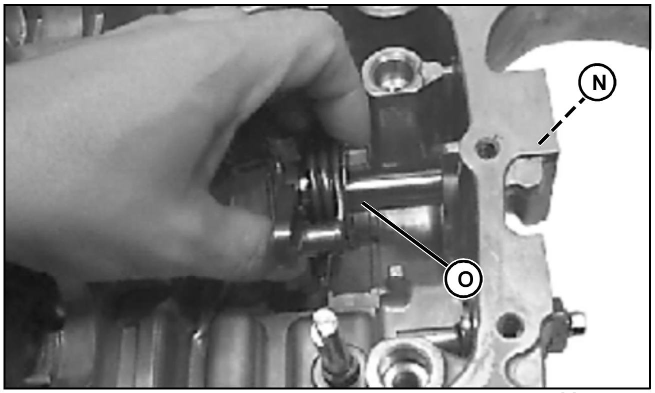


M94930

16.Install spring, collar (L) and washer (K) on control arm.

17.Install snap ring (J).

18.Secure end of spring (closest to control arm) in a vise. Hook other end of spring over control arm pin (M).

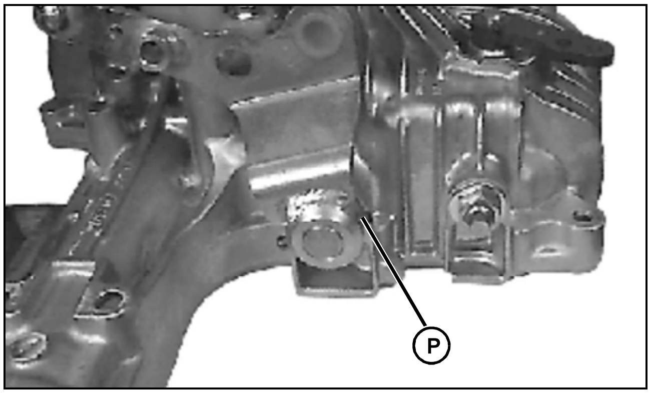


M94929

19.Install a new control arm seal (N) in the case. Apply a light coat of grease to the inside of the seal.

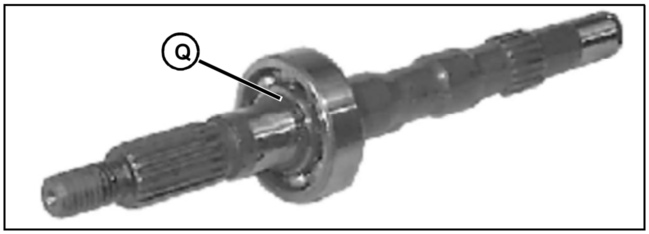
20.Apply a light coat of grease to the control arm shaft hole in the upper case.

21.Install control assembly (O). Ensure the ends of the spring go to each side of the fulcrum eccentric.



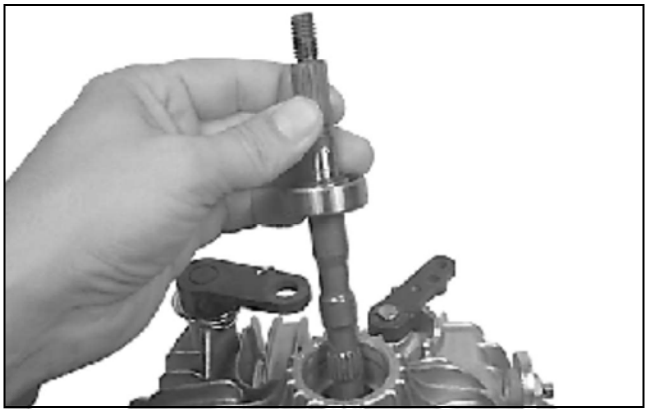
M94928

22.Install control arm on the control shaft. Install roll pin (P).



M94926

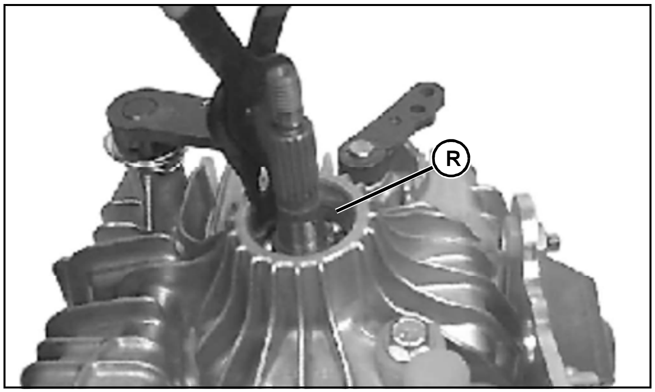
23.Install bearing and two snap rings (Q) on the pump shaft.



M94925

Picture Note: K62B Shown

24.Install pump shaft and bearing assembly in case.

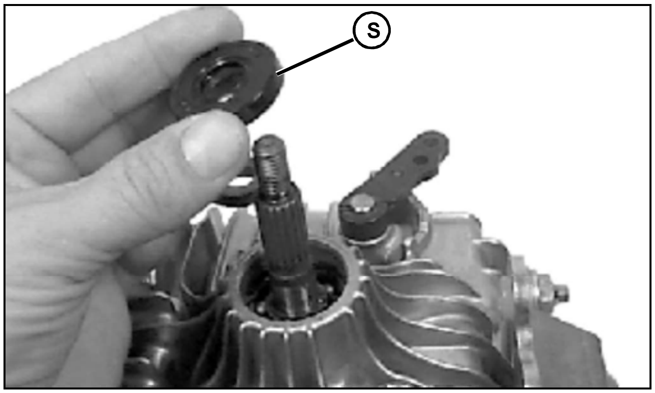


M94925

Picture Note: K62B Shown

25.Install snap ring (R) into case. Ensure snap ring is fully seated in groove.

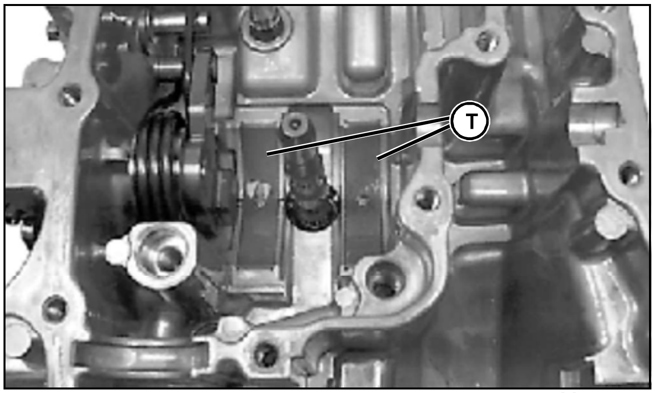
26.Apply grease to the lip of a new seal. Cover the splines of the pump shaft with tape to avoid damage to the new seal.



M94924

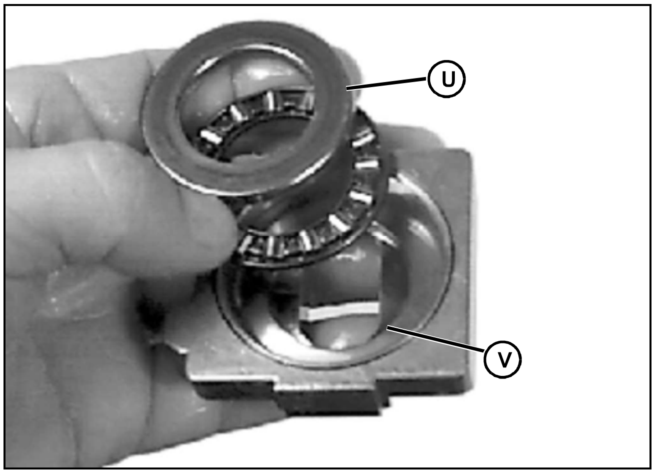
Picture Note: K62B Shown

27.Install seal (S) on pump shaft and seat seal fully in case.



M94923

28.Coat the thrust plates (T) with fresh oil. Install and seat thrust plates in case.



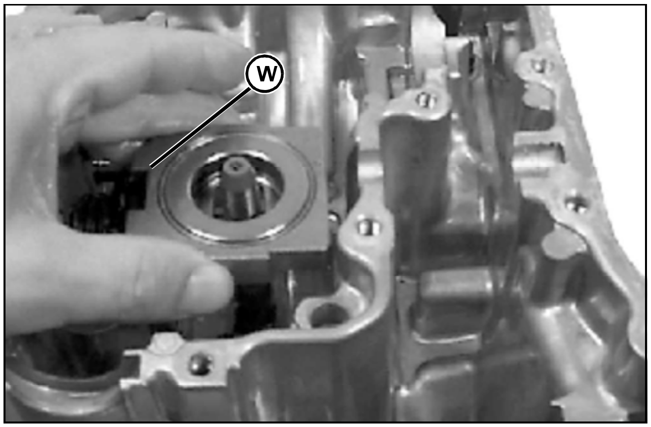
M94922

29.Coat all parts of swash plate assembly with clean transmission oil before installation.

NOTE: Thinner thrust plate (V) installs in swash plate first.

30.Install thin thrust plate (V), bearing and thick thrust plate (U) into swash plate.

NOTE: Swash plate notch (W) Installs toward control arm assembly and mates with shift block.



M94921

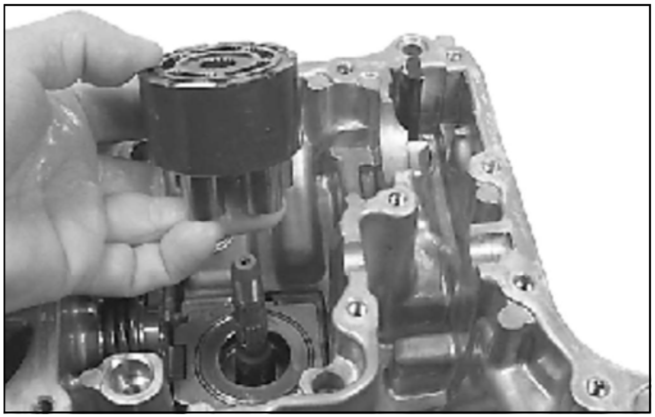
31.Install swash plate assembly in upper case. Ensure swash plate seats fully.

32.Measure space between the swash plate and shift block. If measurement does not meet specification, replace swash plate and/or shift block.

Swash Plate/Shift Block Clearance:

Standard . . . . 0.01 - 0.11 mm (0.0004 - 0.004 in.)

Wear Limit. . . . . 0.15 mm (0.006 in.)



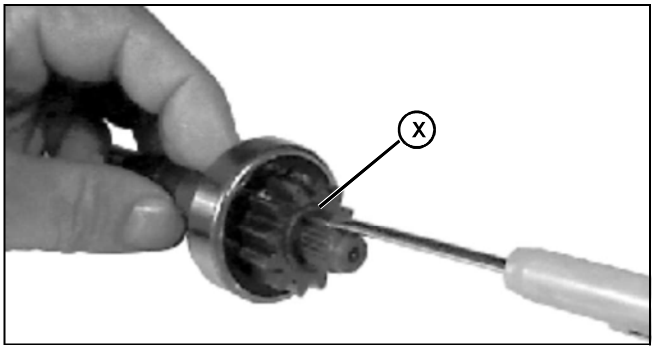
M94919

33.Coat cylinder block, springs and pistons with oil.

NOTE: Pistons can be installed in any cylinder block hole.

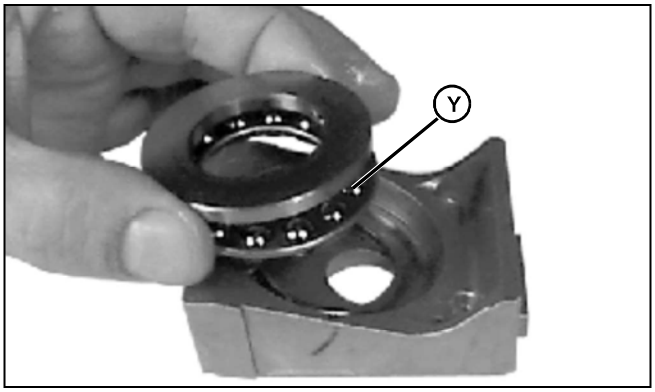
34.Assemble cylinder block, springs and pistons.

35.Install cylinder block assembly over pump shaft being careful to not let pistons fall out. After piston block assembly is installed, push down on assembly to ensure freedom of movement of all pistons.



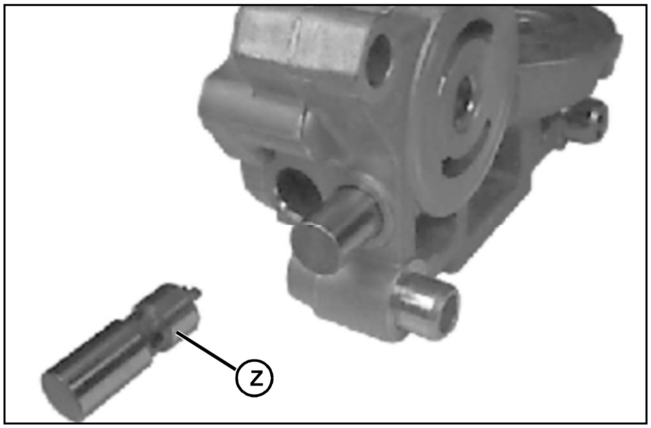
M94918

36.If disassembled, install bearing and gear on motor shaft. Secure with C-clips (X).



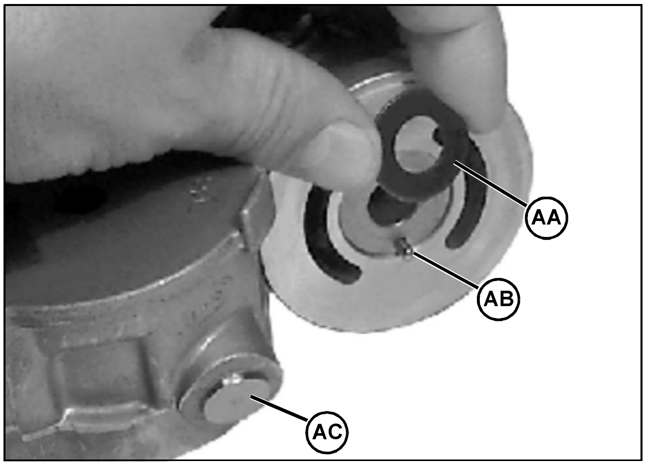
M94917

37.Install thrust bearing (Y) and plate in swash plate.



M94938

38.Coat valve assemblies (Z) with oil and install valve assemblies in center case.



M95058

39.Coat plug (AC) with oil and install in center block.

40.Apply grease to by-pass pin (AB) to hold it in place and install in center block.

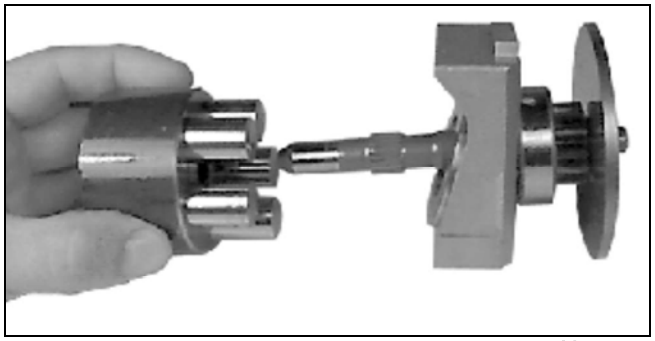
41.Apply grease to by-pass washer (AA) to hold it in place and place washer on center block.

42.Coat cylinder block, springs and pistons with oil.

NOTE: Pistons can be installed in any cylinder block hole.

43.Assemble cylinder block, springs and pistons.

NOTE: Flat side of brake disk installs toward swash plate.



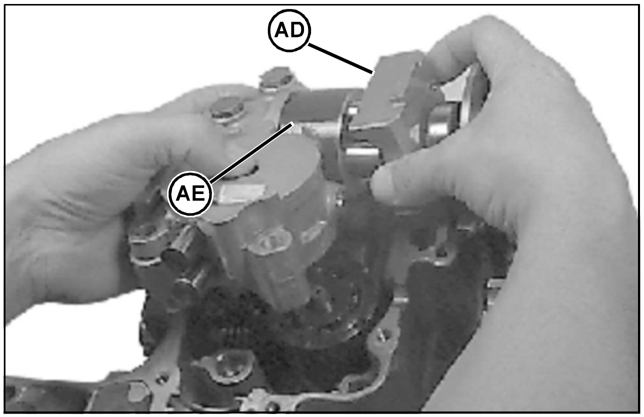
M94916

44.Install motor shaft through swash plate. Install brake disk on motor shaft.

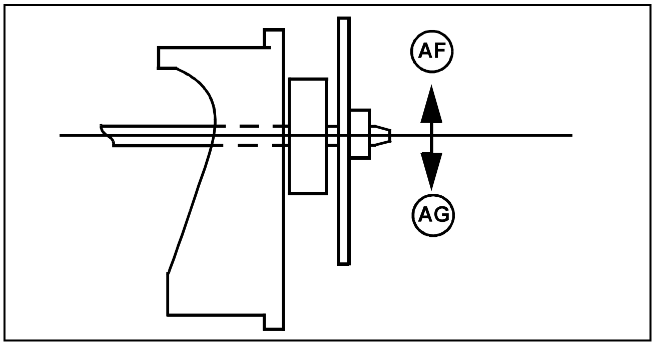
NOTE: When installing motor cylinder on motor shaft, ensure splines on shaft seat in splines in motor cylinder.

45.Place motor cylinder over motor shaft.

IMPORTANT: Avoid damage! Be careful to correctly position swash plate onto cylinder block (AE). If swash plate (AD) is installed upside down the transmission will work in reverse.
When installing center case assembly, be careful to avoid scratching or damaging contact surfaces of center case and cylinder blocks.



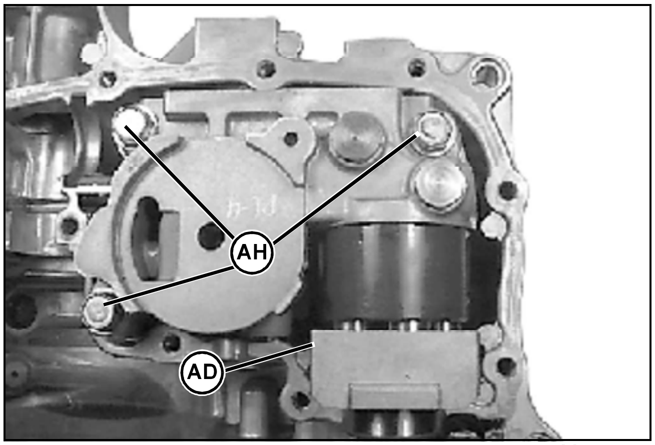
M94914



MIF

46.Press brake disk, swash plate and cylinder block against the center case and compress pistons into cylinder block.

47.Carefully set assembly into transmission case (note bottom (AF) and top (AG) of transaxle). Ensure assembly seats fully with alignment pins and motor shaft bearing set properly.



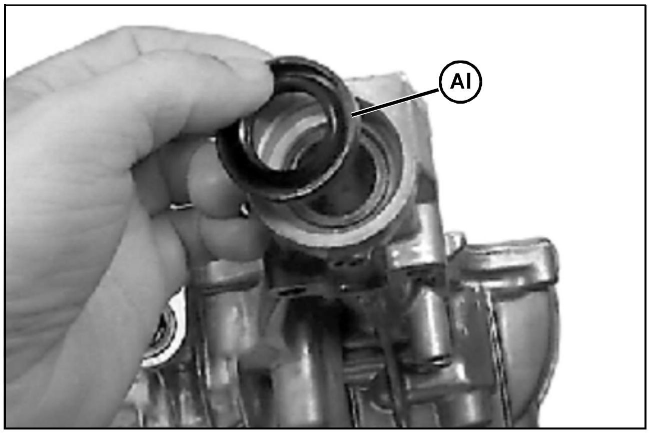
M94913

48.Install three cap screws (AH) securing center case assembly to transaxle case.

49.Tighten cap screws to specification. DO NOT FORCE. If the cap screws are hard to tighten, STOP. Damage can result. Turn the brake disk by hand to ensure motor turns.

Specification:

Cap Screw Torque . . . . 43 N•m (32 lb-ft)



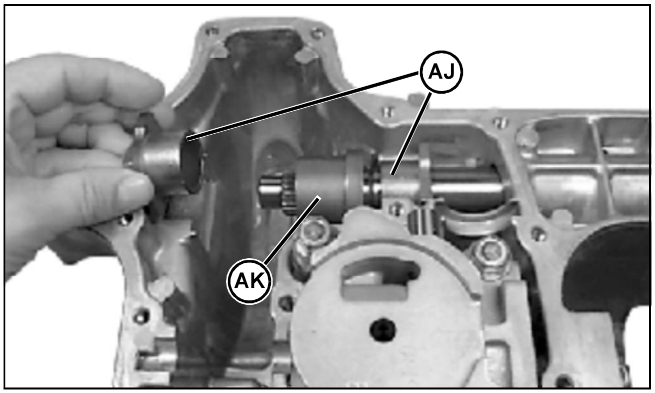
M95059

50.Install new axle seals (AI). Press seals into case until fully seated.

51.Apply grease to inner lip of seals to help avoid damage when installing axles. Apply tape to axle splines before installing axles to help avoid damage to seals.

52.Install longer axle through seal, case and bushing.

53.Install collar on axle. Do not insert axle fully.

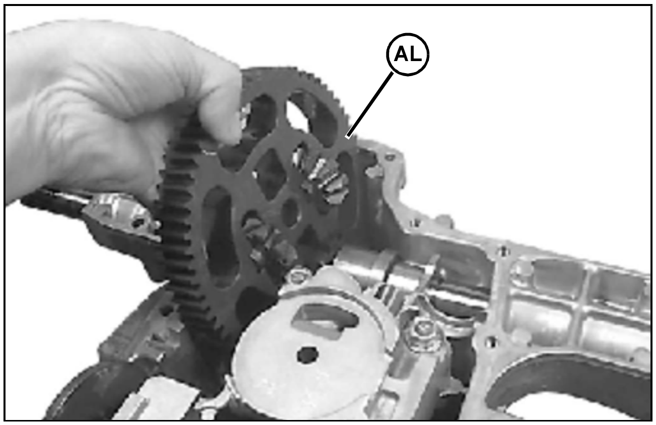


M94910

54.Install bushings (AJ) for shorter axle.

55.Install axle though seal, case and bushing (AK). Do not insert axle fully.

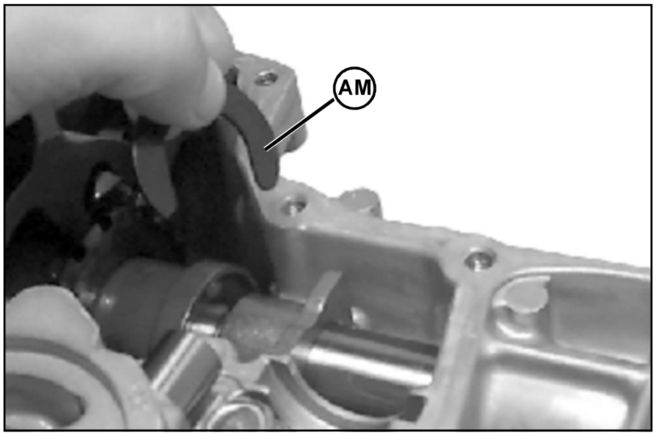
56.Install differential bevel gears onto axles. Slide axles slightly toward each other to set bevel gears on axle splines.



M94909

57.Assemble differential gear assembly (AL) and set between axles.

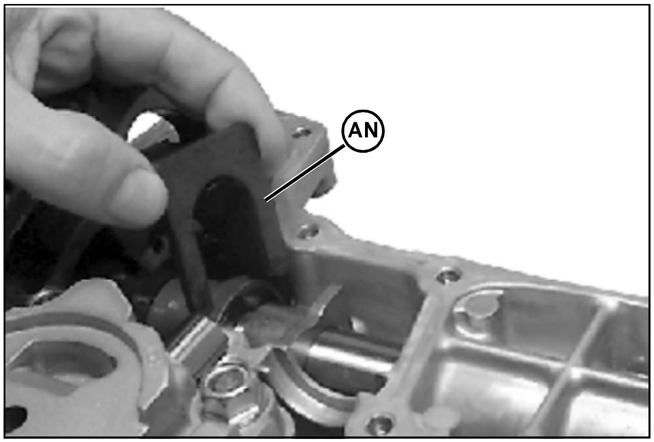
58.Rotate differential gears and axles until all gears mesh.



M94908

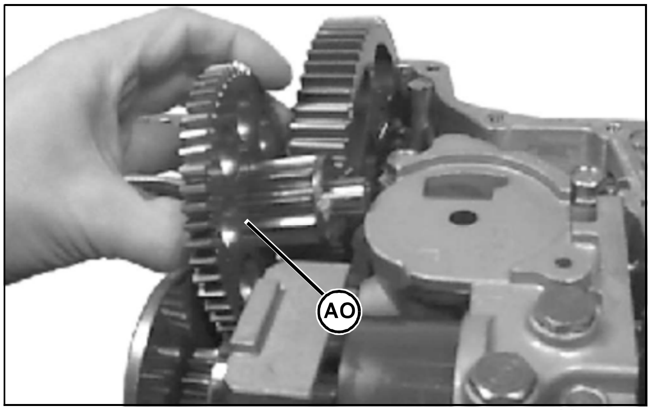
59.Install C-ring (AM) on each axle.

60.Push axles fully into transaxle case. Rotate differential gear to assure freedom of movement.



M94899

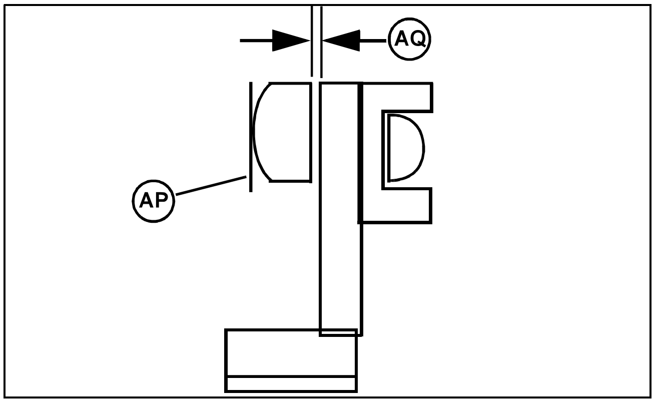
61.Install thrust washer (AN) on left hand and right hand axles.



M94898

62.Install reduction gear assembly (AO) in upper case. Rotate gears if needed to fully seat gear assembly.

IMPORTANT: Avoid damage! Note flat on outer end of reduction shaft. Flat surface must be fully seated in upper case, and flat surface must be perpendicular to case to allow seating of lower case on upper case.



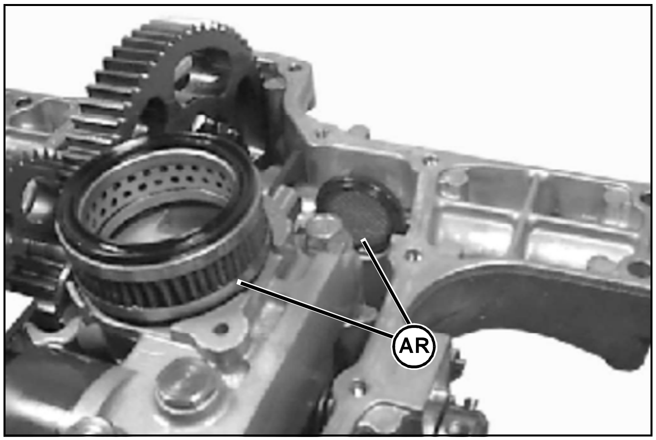
MIF

63.Install brake shoe. Measure distance between brake shoe and brake disk. Shim (AP) brake shoe to set clearance to specification (AQ).

Specification:

Clearance (AQ) . . . . 0.8 - 1.3 mm (0.03 - 0.05 in.)

NOTE: Shim set includes 0.3 mm (0.01 in.) shim and 0.5 mm (0.02 in.) shim.



M94897

64.Install oil filters (AR).

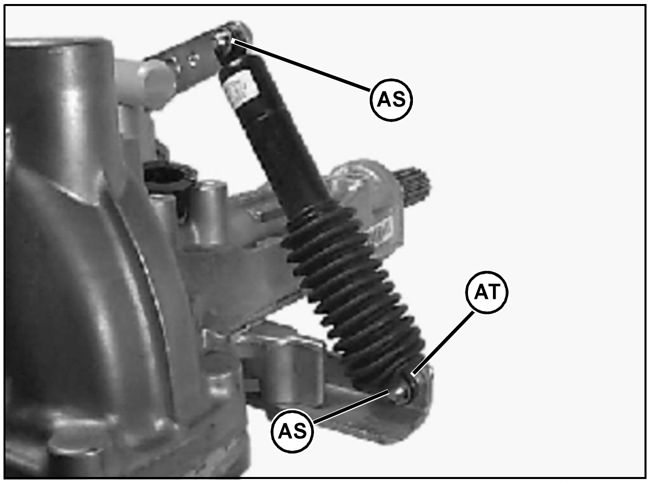
65.Install a bead of sealant on mating surfaces of lower case. Use care to ensure an even bead that extends around all bolt and cap screw holes.

66.Place lower case on upper case. Ensure cases fully seat without having to use force.

67.Install twelve cap screws and five bolts. Tighten cap screws and bolts to specification.

Specification:

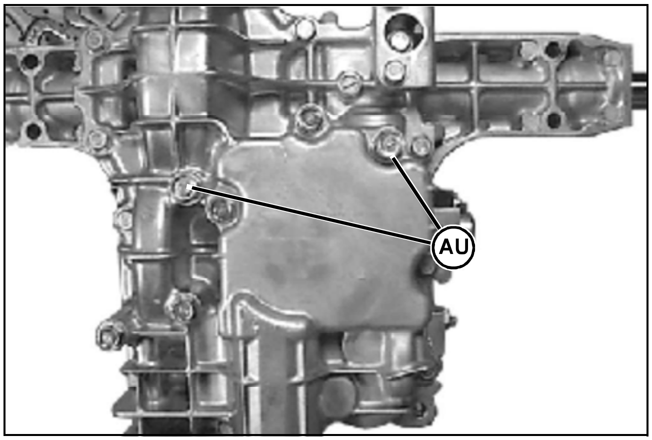
Cap Screw Torque
Same Case . . . . 24 N•m (17 lb-ft)
New Case. . . . . 29 N•m (21 lb-ft)
Bolt Torque . . . . 26.5 N•m (19 lb-ft)



M94896

68.Install collar (AT) then shock absorber to transaxle. Secure with two E-clips (AS).

NOTE: Replace two seal washers on drain bolts (AU) before installing.

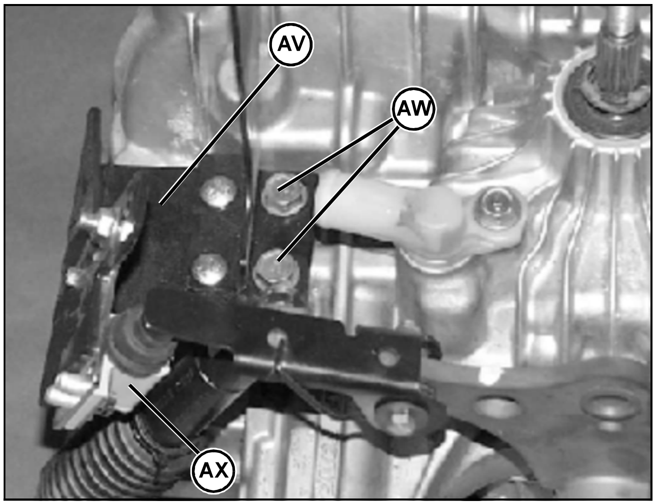


M94895

69.Install oil drain bolts with new seal washers into transaxle. Tighten to specification.

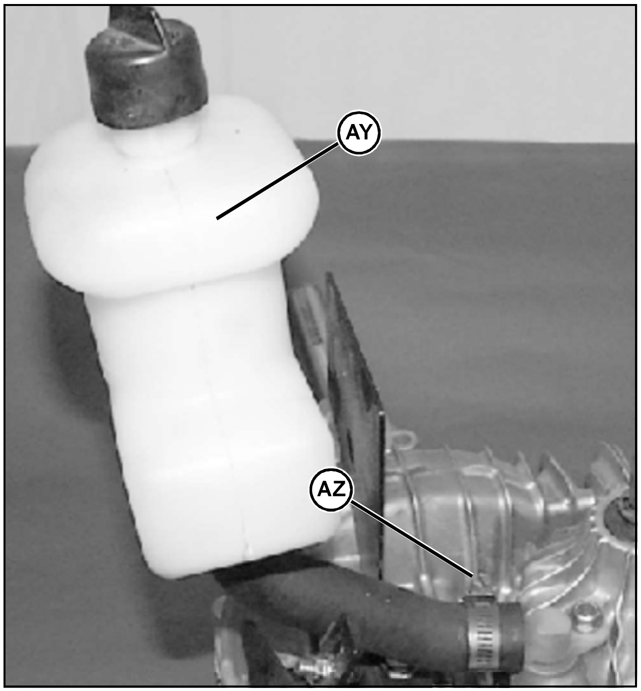
Specification:

Drain Bolt Torque . . . . 14.7 N•m (130 lb-in.)



M99634

70.Install RIO switch (AX) bracket (AV). Retain with two cap screws (AW).



M99632

71.Install reservoir bottle (AY) and retain with hose clamp (AZ).

NOTE: Due to internal filters and baffles, it is necessary to fill the transaxle though the fill tube and the overflow reservoir tube.

72.Fill transaxle with 2.5 L (2.7 qt) of SAE 5W or 10W30 Oil (Synthetic or Mineral) or John Deere HY-GARD™ J20C Oil.

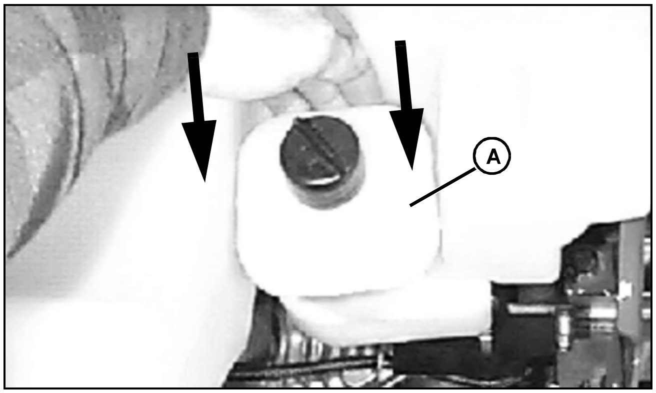
NOTE: After transaxle installation and transmission oil reservoir installation, top off reservoir with 0.47 L (0.5 qt) of oil.

Traction Drive Belt Removal and Installation

Removal:

1. Remove mower deck. See Mower Deck Removal and Installation for the appropriate mower deck in the Attachments section.

2. Remove fender deck. See “Fender Deck Removal and Installation” on page 590 in the Miscellaneous section.



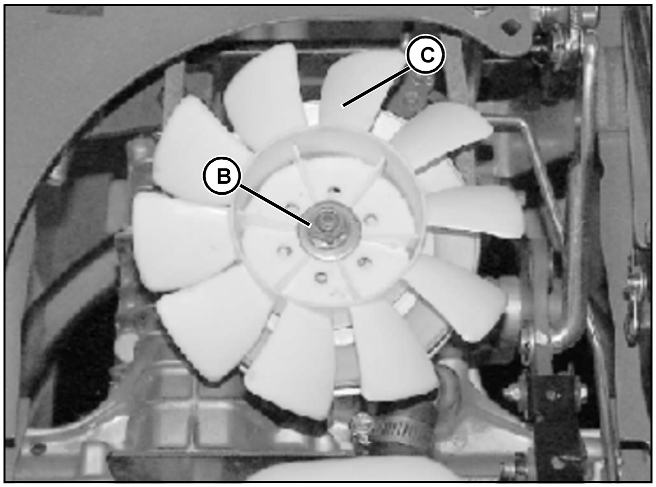
M95320

3. Push hydrostatic transaxle oil reservoir (A) rearward, and disconnect it from the fuel tank.

⚠ **CAUTION: Avoid injury! Gasoline is extremely flammable. Do not smoke. Always work in a ventilated area away from open flame or spark producing equipment; including equipment that utilizes pilot lights. Wipe-up any spills IMMEDIATELY.**

4. Lift and remove fuel tank from machine frame. Set fuel tank aside.

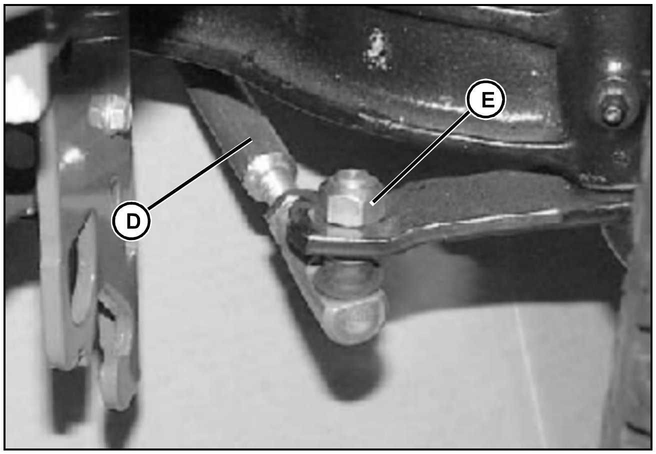
Two Wheel Steer Model:



M99624

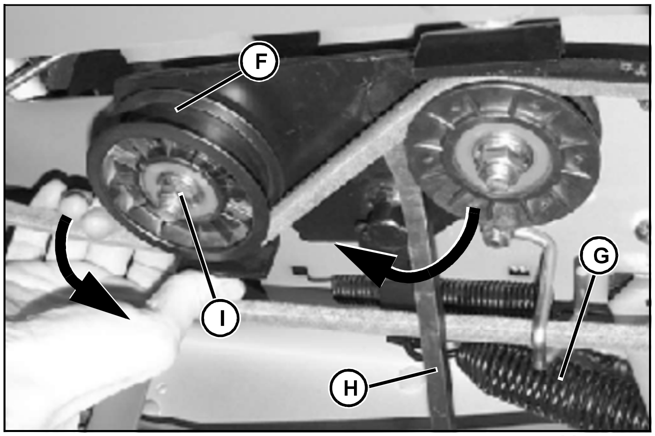
1. Remove locknut and washer (B), and transaxle cooling fan (C).

2. Slip belt off of input sheave and input shaft.



M95522

3. Remove locknut (E) securing drag link (D) to left front wheel steering arm. Move drag link out of the way.

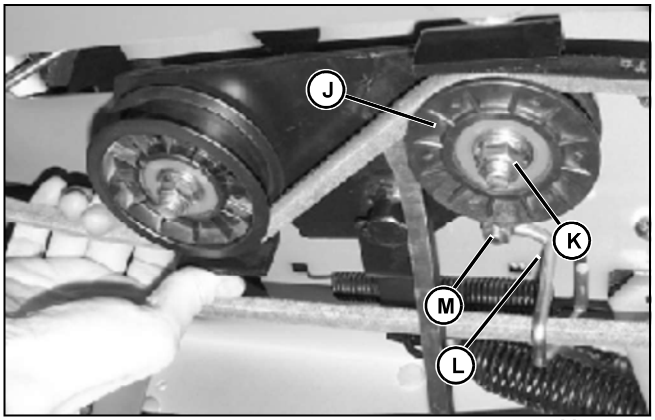


M99618

4. On underside of machine, locate the traction drive belt tensioner. Loosen nut (I) on flat idler (F).

5. Using a pry bar (H), turn belt tensioner to relieve tension on belt, and slip belt off of flat idler (F).

6. Remove spring (G).

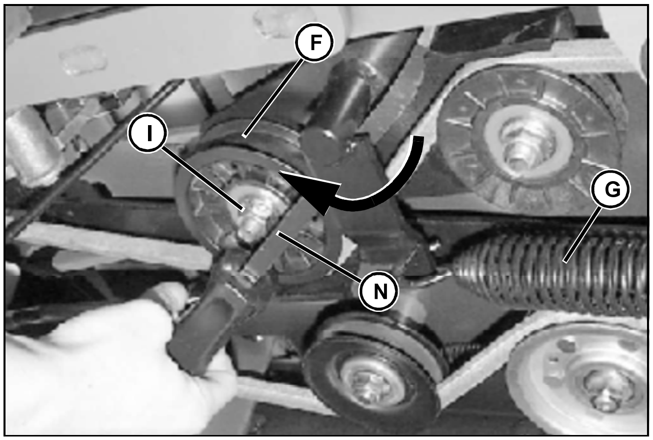


M99618

7. Remove nut (M), cap screw, and belt guide (L).

8. Loosen nut (K) on V-idler (J). Slip belt off of V-idler.

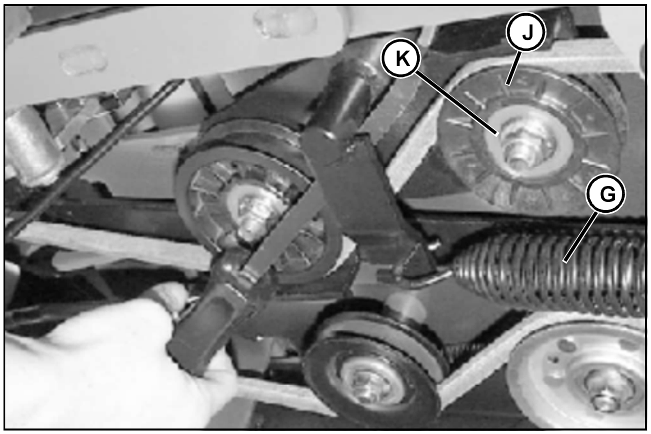
All Wheel Steer Model:



M99679

1. Loosen nut (I) on flat idler (F).

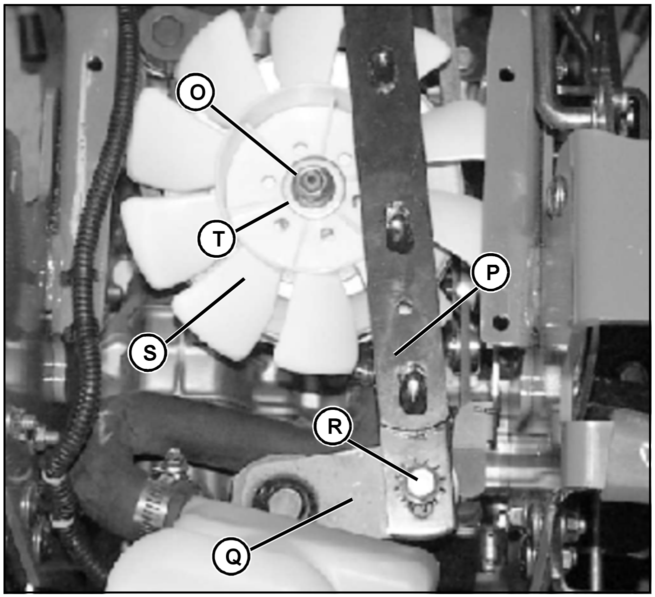
2. Using a pry bar (N), pull belt tensioner assembly against spring (G) tension and slip belt off of flat idler.



M99679

3. Using a suitable spring puller, remove spring (G).

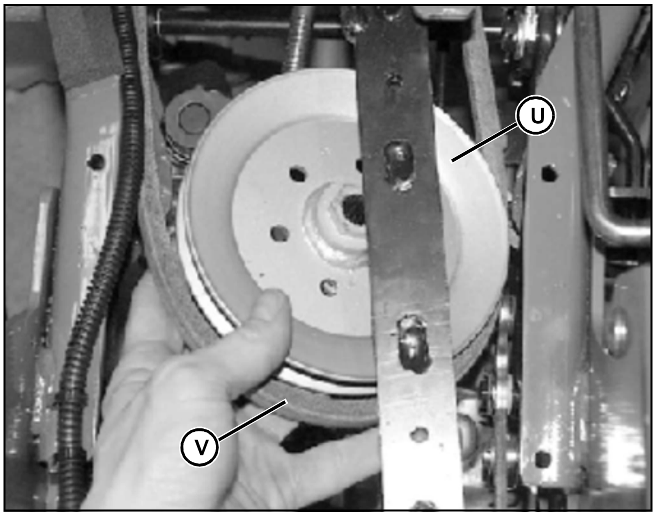
4. Loosen nut (K) on V-idler (J). Slip belt off of V-idler.



M99681

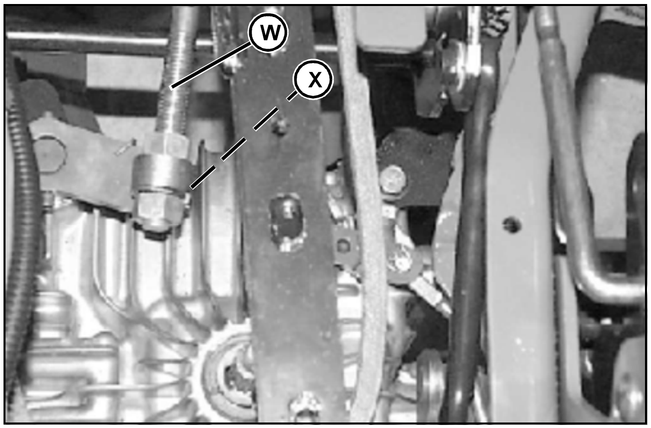
5. Remove cap screw (R), internal/external tooth lock washer, locknut, and spacer. Disconnect control strap (P) from rear pivot (Q).

6. Remove locknut (O), washer (T), and transaxle cooling fan (S).



M99682

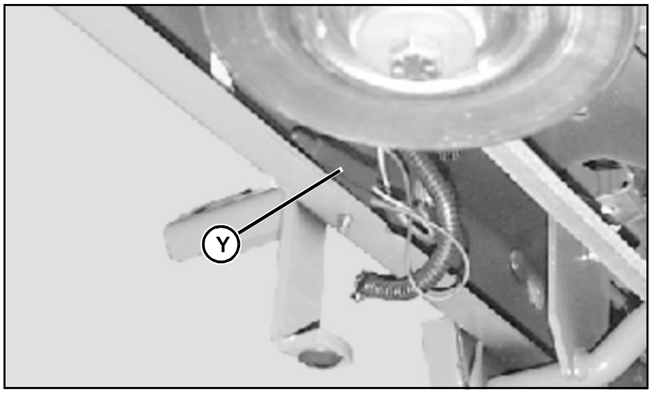
7. Lift input sheave (U) off top of transaxle. Slip drive belt (V) off of sheave and move aside. Remove sheave.



M99688

8. Remove cotter pin and washer (X) and disconnect brake rod (W) from transaxle control lever.

All Models:



M95555

1. Disconnect PTO clutch wiring harness connector (Y).
2. Remove traction drive belt from the machine.

Installation:

Installation is the reverse of removal.

NOTE: On all wheel steering machines, perform rear wheel alignment before installing fenderdeck. See "Rear Wheel Alignment - AWS" on page 473 in Steering section.

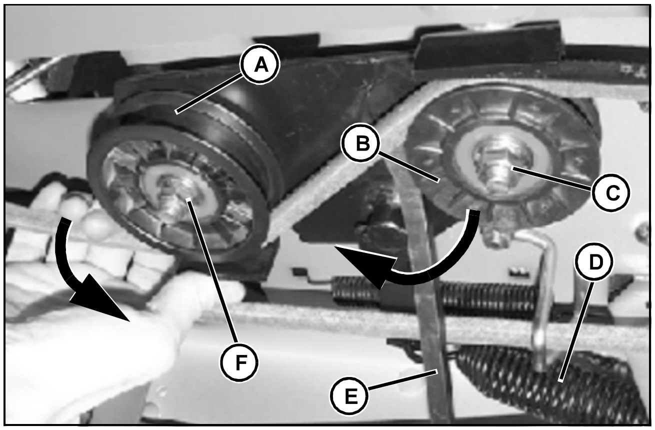
Traction Drive Belt Tensioner Assembly

Removal:

1. Remove mower deck. See Mower Deck Removal and Installation for the appropriate mower deck in the Attachments section.

2. Remove fender deck. See “Fender Deck Removal and Installation” on page 590 in the Miscellaneous section.

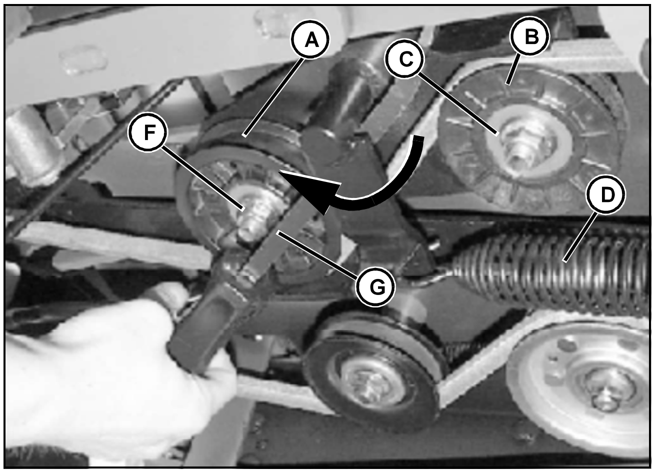
Two-Wheel Steer Model (2WS):



M99618

1. On underside of machine, locate the traction drive belt tensioner. Loosen nut (F) on flat idler (A).
2. Using a pry bar (E), turn belt tensioner to relieve tension on belt, and slip belt off of flat idler.
3. Rotate tensioner assembly and remove spring (D).
4. Loosen nut (C) on V-idler (B). Slip belt off of V-idler.

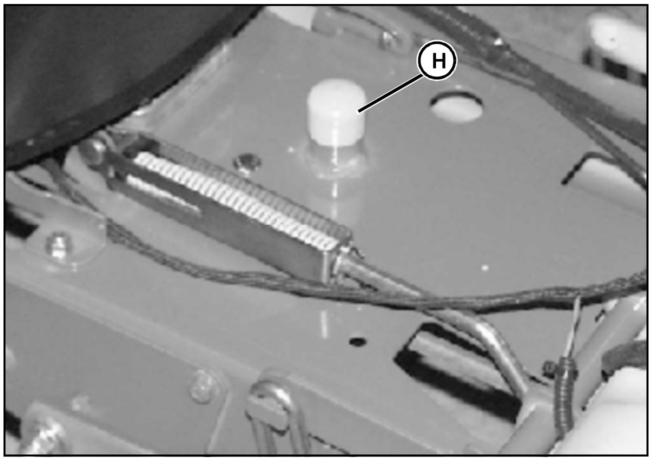
All Wheel Steer Model (AWS):



M99679

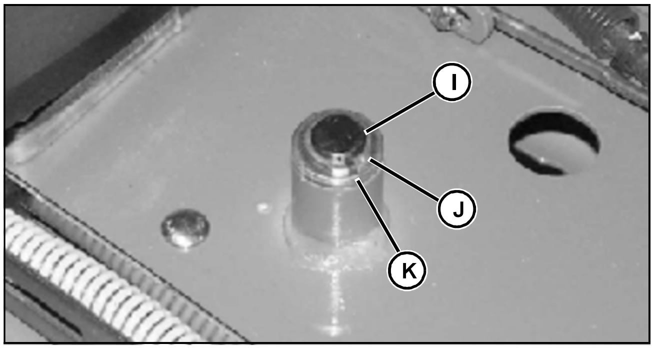
1. Loosen nut (F) on flat idler (A).
2. Using a pry bar as shown (G), pull belt tensioner assembly against spring (D) tension and slip belt off of flat idler.
3. Loosen nut (C) on V-idler (B). Slip belt off of V-idler.
4. Using a suitable spring puller, remove spring (D).

All Models:



M99589

1. Remove cap (H) on tensioner pivot.



M99590

2. Remove snap ring (I).
3. Remove washer (J) and bushing (K).
4. Remove tensioner assembly from underside of machine.
5. Inspect idlers for wear or damage. Inspect bearings for smooth operation or damage. Replace parts as needed.
6. Inspect bushings and felt seal on idler pivot. Replace parts as needed.

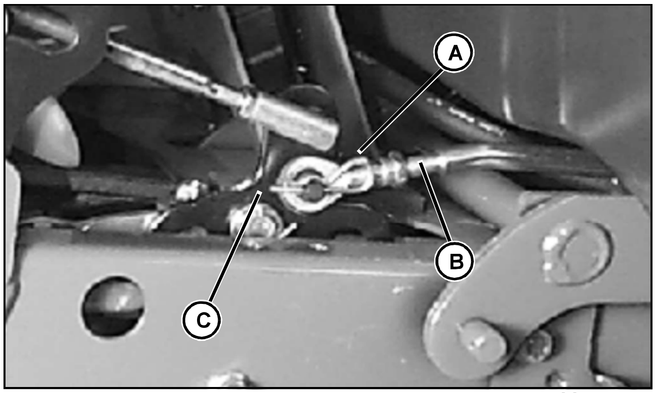
Installation:

Installation is the reverse of removal.

Control Pedals and Linkage

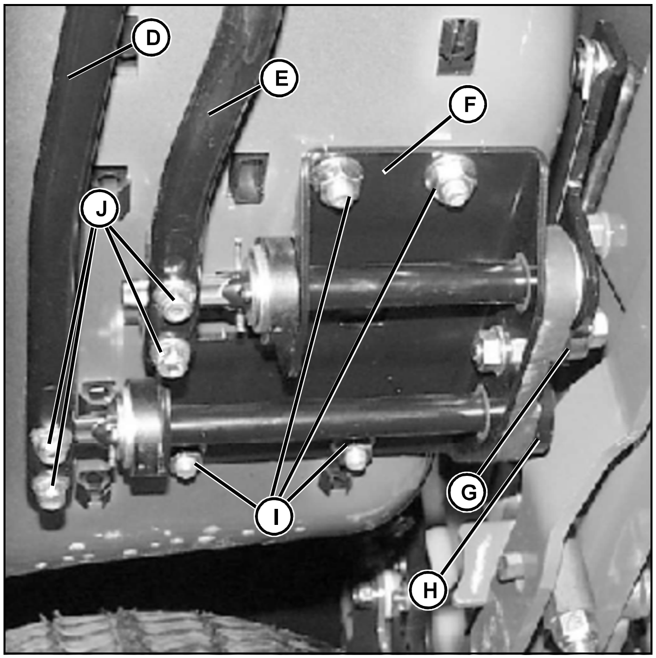
Pedal Assembly Removal:

1. Remove mower deck. See the appropriate Mower Deck Removal and Installation procedure in the Attachments section.



M95315

2. Behind right rear wheel, locate and remove spring clip pin (A), and disconnect forward/reverse control rod (B) from control lever (C).



M99587

3. Loosen four locknuts (J) attaching forward (E) and reverse (D) pedals to control shafts. Remove pedals.

4. Remove four nuts (I) securing bracket (F) to fender deck.

5. Lower pedal assembly and move toward front of machine. Remove pedal assembly.

6. Inspect components for wear or damage. Replace parts as needed.

Pedal Assembly Installation:

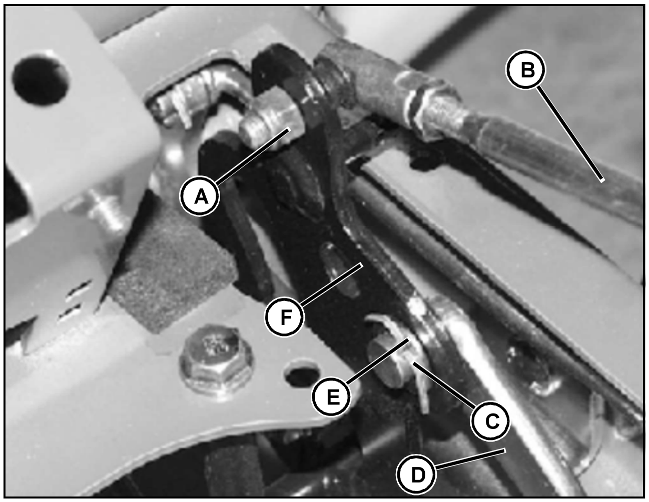
Installation is the reverse of removal.

- When installing bracket and control shafts, be sure that arm (H) on end of reverse pedal shaft is in contact with bearing (G) on forward pedal shaft.
- When installing forward and reverse pedals, be sure pedals do not rub against foot mat or fender deck. Check entire range of pedal motion for interference.
- Perform pedal height adjustment. See “Forward and Reverse Pedal Height Adjustment” on page 409.

Intermediate Shaft

Removal:

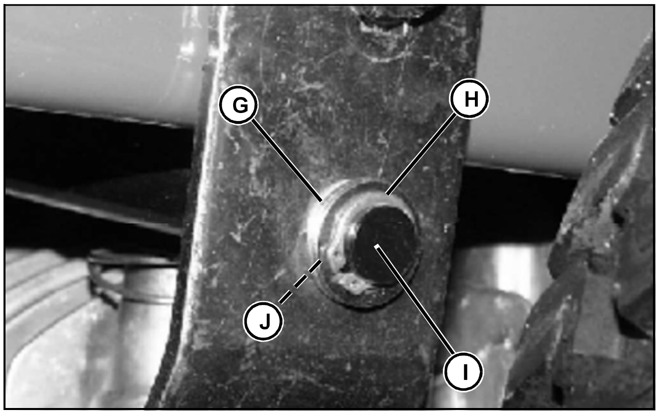
1. Remove fender deck. See “Fender Deck Removal and Installation” on page 590 in the Miscellaneous section.



M99607

2. Remove locknut (A) attaching hand lever rod (B) to intermediate shaft plate (F). Disconnect rod.

3. Remove cotter pin (C) and washer (E) attaching transaxle control rod (D) to intermediate shaft plate. Disconnect rod.



M99609

4. Remove snap ring (H) and washer(s) (G) from both ends of intermediate shaft (I). Slide shaft to left side of machine until free of right bushing (J). Rotate shaft until lever is clear of the frame. Slide shaft to right side of machine and remove.

5. Remove two bushings.

6. Inspect components for wear or damage. Replace parts as needed.

Installation:

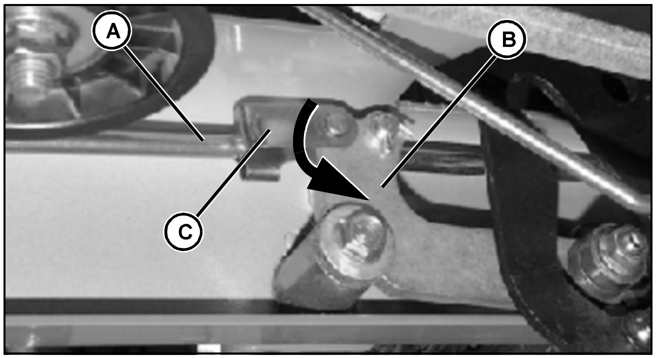
Installation is the reverse of removal.

NOTE: If forward/reverse control rod end becomes loose during fender deck removal and installation, perform pedal height adjustment procedure. See "Forward and Reverse Pedal Height Adjustment" on page 409.

Neutral Return Arm

Removal:

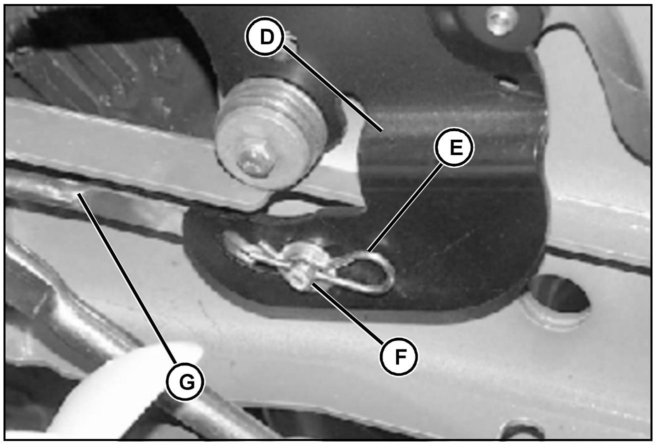
1. Remove fender deck. See "Fender Deck Removal and Installation" on page 590 in the Miscellaneous section.



M99608

2. Rotate retainer (C) and disconnect neutral return rod (A) from neutral return arm (B).

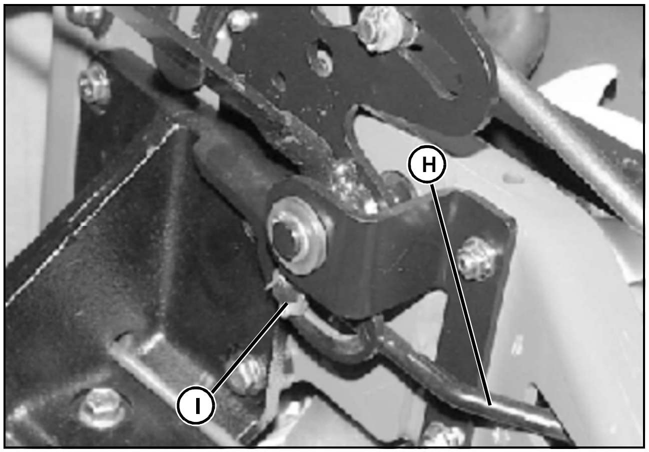
Two Wheel Steer Model:



M99611

1. Remove spring clip pin (E) and washer (F) attaching cruise control interlock rod (G) (if equipped) to cruise control lever (D). Disconnect rod from lever.

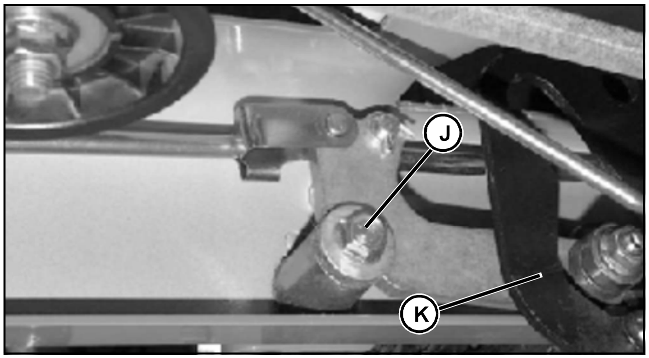
All Wheel Steer Model:



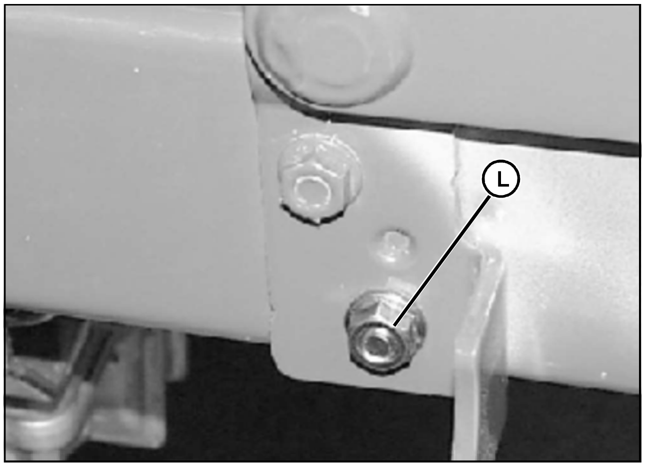
M99699

1. Remove cotter pin and bushing (I), and disconnect cruise control interlock rod (H).

All Models:

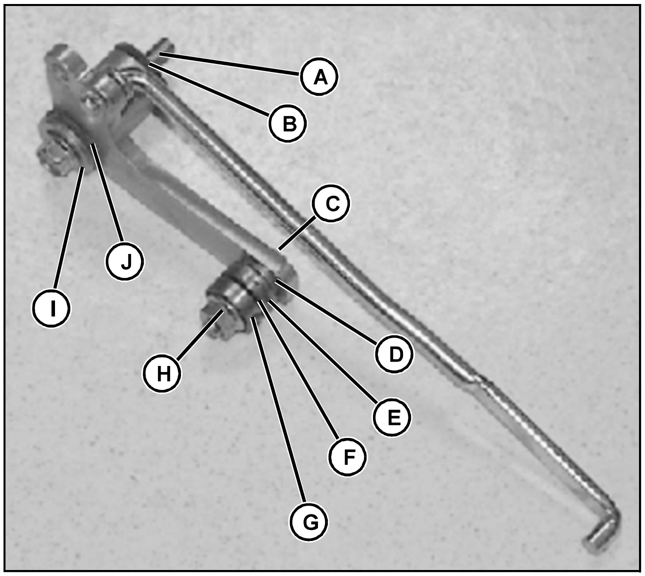


M99608



M99612

1. Remove nut (L) and cap screw (J) retaining neutral return arm to frame. Turn arm to clear intermediate shaft plate (K) and remove.



A - **Cap Screw**
B - **Felt Seal**
C - **Carriage Bolt**
D - **Washers (2 used)**
E - **Bearing**
F - **Washer**
G - **Bearing**
H - **Nut**
I - **Bushing**
J - **Felt Seal**

2. Inspect components for wear or damage. Replace parts as needed.

Installation:

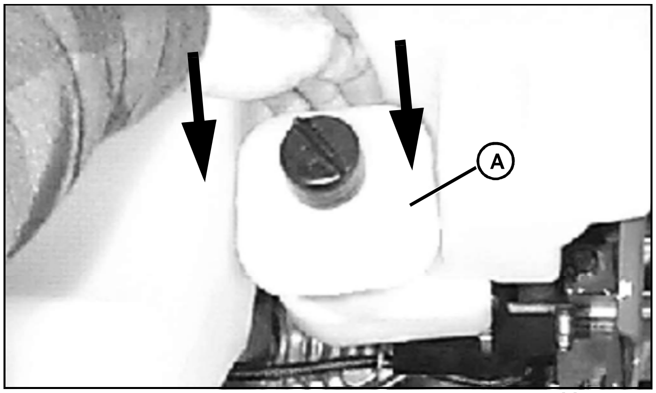
Installation is the reverse of removal.

- When installation is complete, perform neutral return arm bearing adjustment. See “Neutral Return Arm Bearing Adjustment” on page 410.

Cruise Control Lever (2WS Model)

Removal:

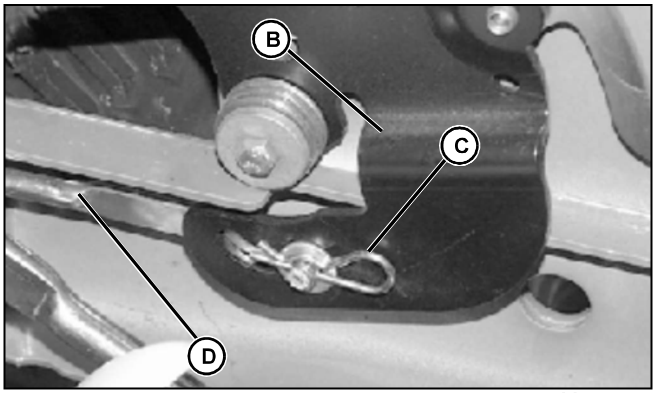
1. Remove fender deck. See “Fender Deck Removal and Installation” on page 590 in the Miscellaneous section.



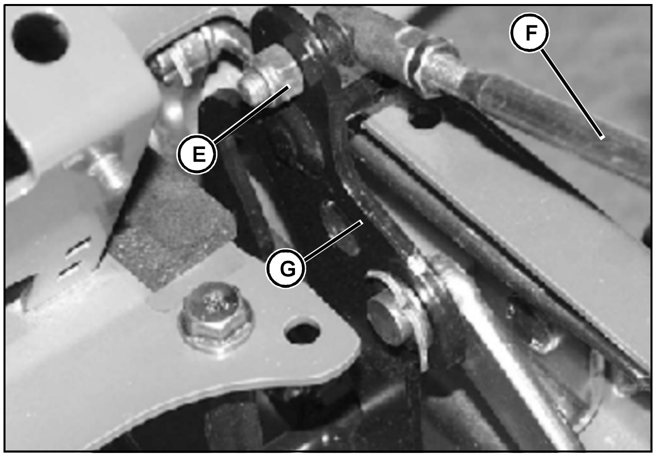
2. Push hydrostatic transaxle oil reservoir (A) rearward, and disconnect it from the fuel tank.

CAUTION: Avoid injury! Gasoline is extremely flammable. Do not smoke. Always work in a ventilated area away from open flame or spark producing equipment; including equipment that utilizes pilot lights. Wipe-up any spills IMMEDIATELY.

3. Lift and remove fuel tank from machine frame. Set fuel tank aside.



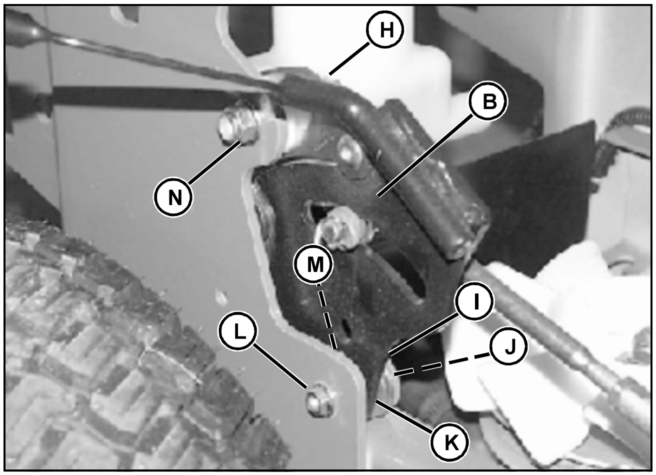
4. Remove spring clip pin (C) and washer attaching cruise control interlock rod (D) to cruise control lever (B). Disconnect rod from lever.



M99607

5. Remove locknut (E) attaching hand lever rod (F) to intermediate shaft plate (G).

IMPORTANT: Avoid damage! When removing friction device (H) and cruise control lever (B), note location and quantity of washers (M) during removal to ensure correct reassembly.



M99610

6. Remove locknut (N) retaining friction device (H). Remove friction device.

7. Remove nut (L), washer (M), spring assembly (K), bushing (I), and cap screw (J) attaching cruise control lever (B) assembly to machine frame.

8. Remove cruise control lever.

Installation:

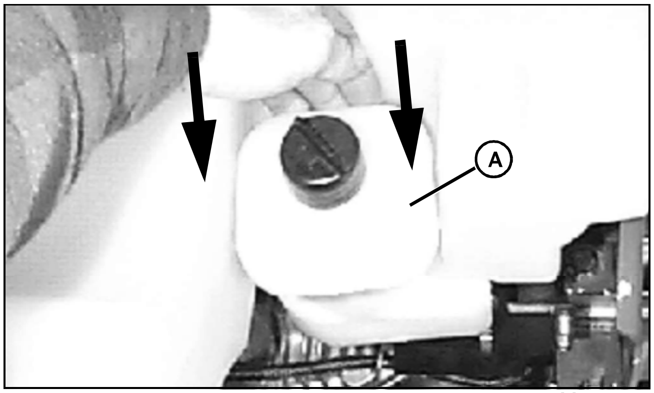
Installation is the reverse of removal.

- When installation is complete, perform hand control lever friction adjustment and hand lever rod adjustment. See "Cruise/Hand Control Lever Tension Adjustment" on page 410, and "Hand Lever Rod Adjustment" on page 409.

Cruise Control Lever (AWS Model)

Removal:

1. Remove fender deck. See "Fender Deck Removal and Installation" on page 590 in the Miscellaneous section.

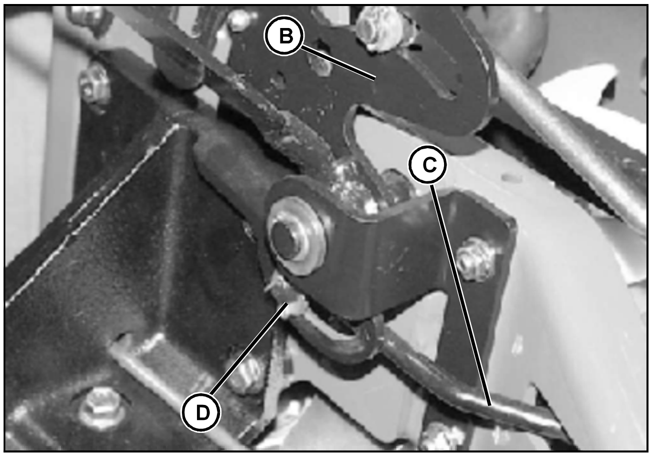


M95320

2. Push hydrostatic transaxle oil reservoir (A) rearward, and disconnect it from the fuel tank.

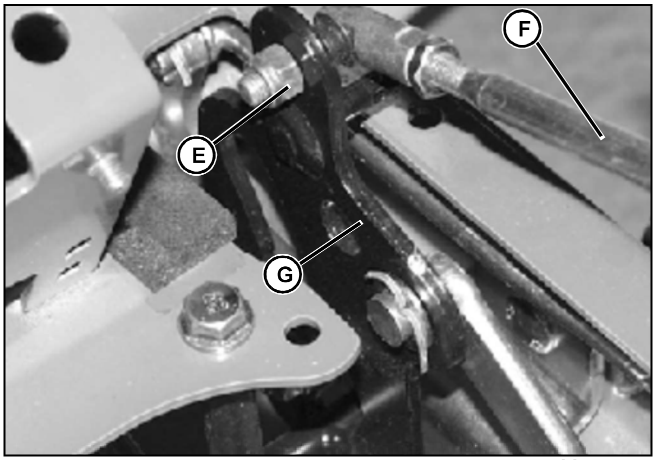
CAUTION: Avoid injury! Gasoline is extremely flammable. Do not smoke. Always work in a ventilated area away from open flame or spark producing equipment; including equipment that utilizes pilot lights. Wipe-up any spills IMMEDIATELY.

3. Lift and remove fuel tank from machine frame. Set fuel tank aside.



M99699

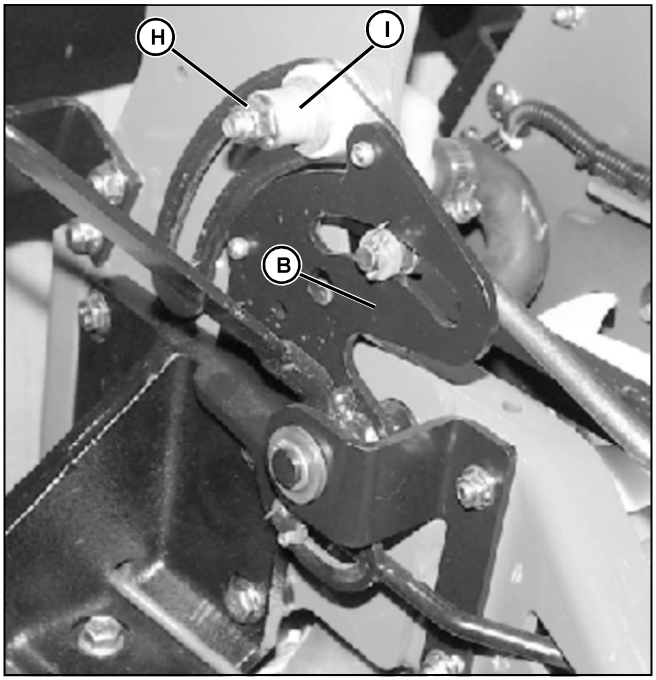
4. Remove cotter pin and washer (D) attaching cruise control interlock rod (C) to cruise control lever (B). Disconnect interlock rod from cruise control lever.



M99607

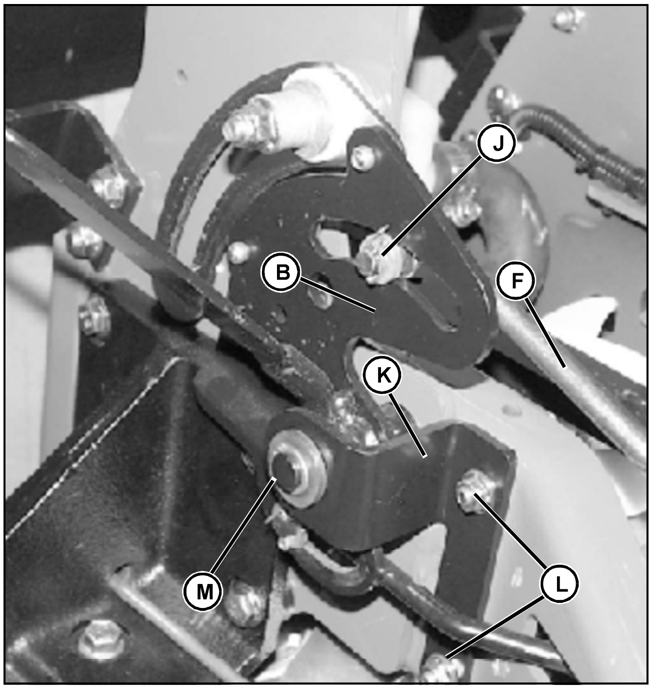
5. Remove locknut (E) attaching hand lever rod (F) to intermediate shaft plate (G).

IMPORTANT: Avoid damage! When removing friction device (I) and cruise control lever (B), note location and quantity of washers during removal to ensure correct reassembly.



M99699

6. Remove locknut (H) retaining friction device (I). Remove friction device.



M99699

7. Remove cotter pin and bushing (J) securing hand lever rod (F) to cruise control lever (B). Disconnect hand lever rod from cruise control lever.

8. Remove outer snap ring and washer (M) (two used) on cruise control lever shaft.

9. Remove two nuts (L), two cap screws, and support bracket (K).

10.Remove inner snap ring and washer from cruise control lever shaft. Remove cruise control lever.

Installation:

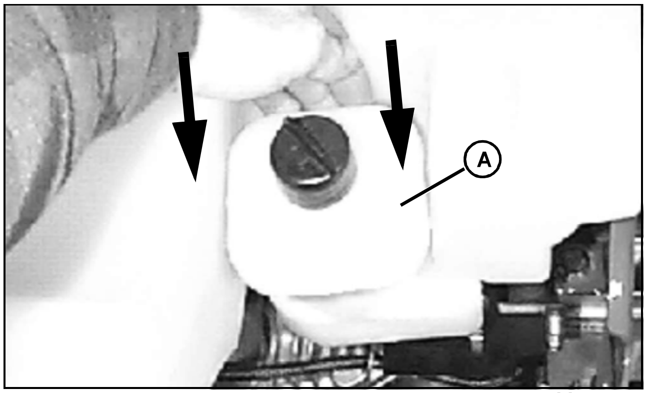
Installation is the reverse of removal.

- When installation is complete, perform hand control lever friction adjustment and hand lever rod adjustment. See “Cruise/Hand Control Lever Tension Adjustment” on page 410 and “Hand Lever Rod Adjustment” on page 409.

Hand Control Lever (Optional) (2WS Model)

Removal:

1. Remove fender deck. See “Fender Deck Removal and Installation” on page 590 in the Miscellaneous section.

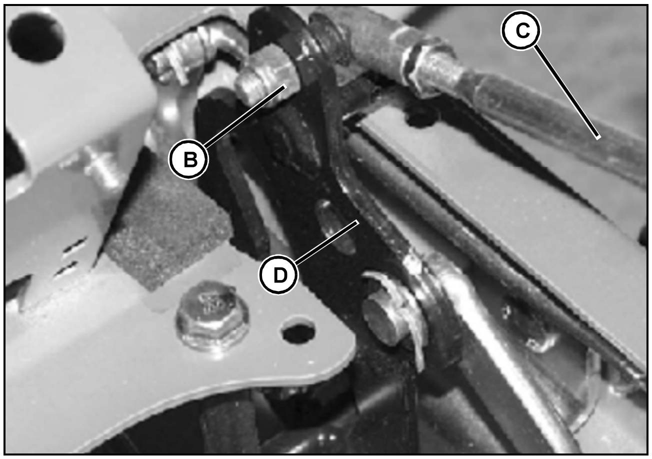


M95320

2. Push hydrostatic transaxle oil reservoir (A) rearward, and disconnect it from the fuel tank.

CAUTION: Avoid injury! Gasoline is extremely flammable. Do not smoke. Always work in a ventilated area away from open flame or spark producing equipment; including equipment that utilizes pilot lights. Wipe-up any spills IMMEDIATELY.

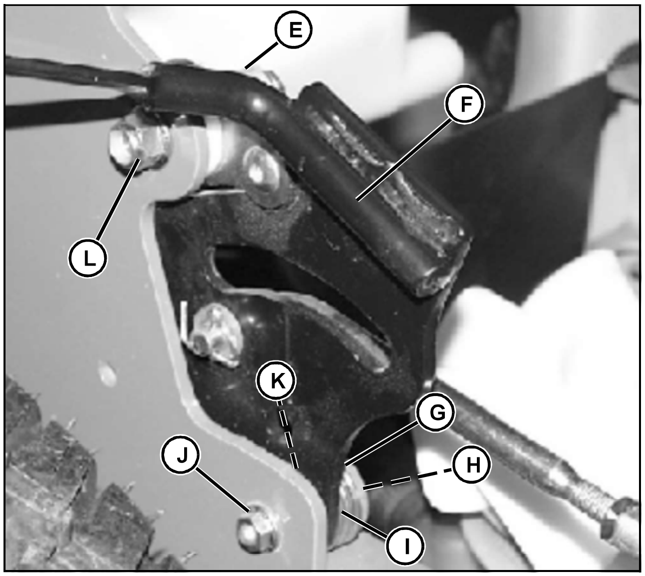
3. Remove fuel tank from machine and set aside.



M99607

4. Remove locknut (B) attaching hand lever rod (C) to intermediate shaft plate (D).

IMPORTANT: Avoid damage! When removing friction device (E) and hand control lever (F), note location and quantity of washers during removal to ensure correct reassembly.



M99615

5. Remove locknut (L) retaining friction device (E). Remove friction device.

6. Remove nut (J), washer (K), spring assembly (I), bushing (G), cap screw (H), and pivot assembly attaching hand control lever assembly to machine frame.

7. Remove hand control lever.

Installation:

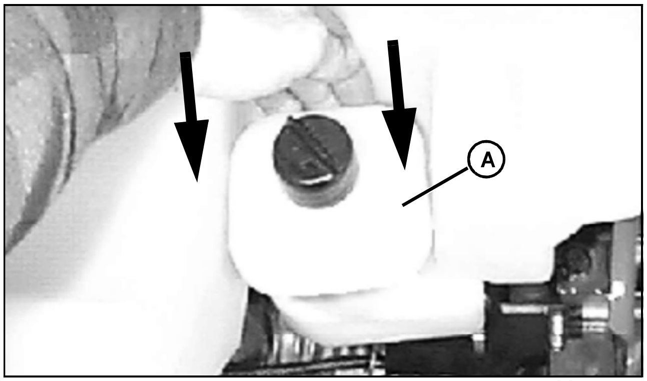
Installation is the reverse of removal.

- When installation is complete, perform hand control lever friction adjustment and hand lever rod adjustment. See “Cruise/Hand Control Lever Tension Adjustment” on page 410 and “Hand Lever Rod Adjustment” on page 409.

Hand Control Lever (Optional) (AWS Model)

Removal:

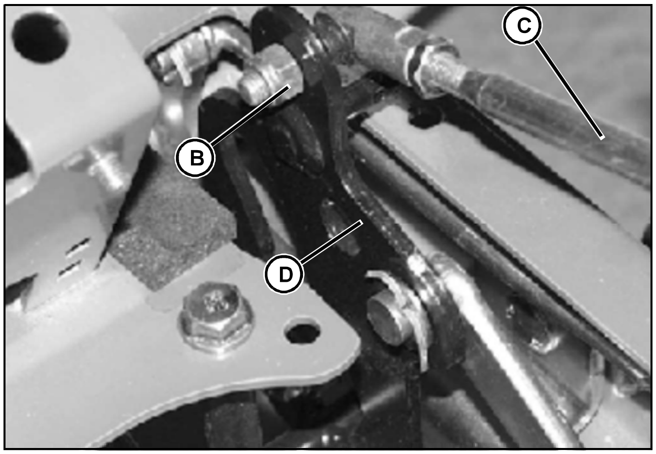
1. Remove fender deck. See “Fender Deck Removal and Installation” on page 590 in the Miscellaneous section.



M95320

2. Push hydrostatic transaxle oil reservoir (A) rearward, and disconnect it from the fuel tank.

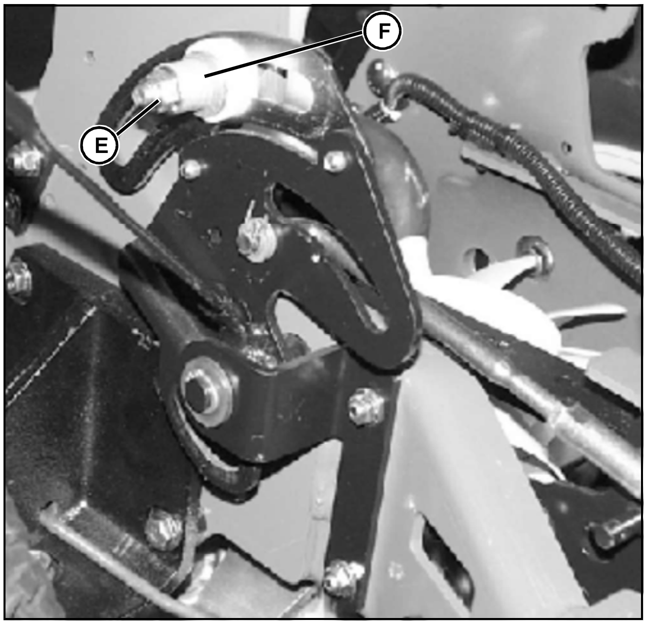
CAUTION: Avoid injury! Gasoline is extremely flammable. Do not smoke. Always work in a ventilated area away from open flame or spark producing equipment; including equipment that utilizes pilot lights. Wipe-up any spills IMMEDIATELY.



M99607

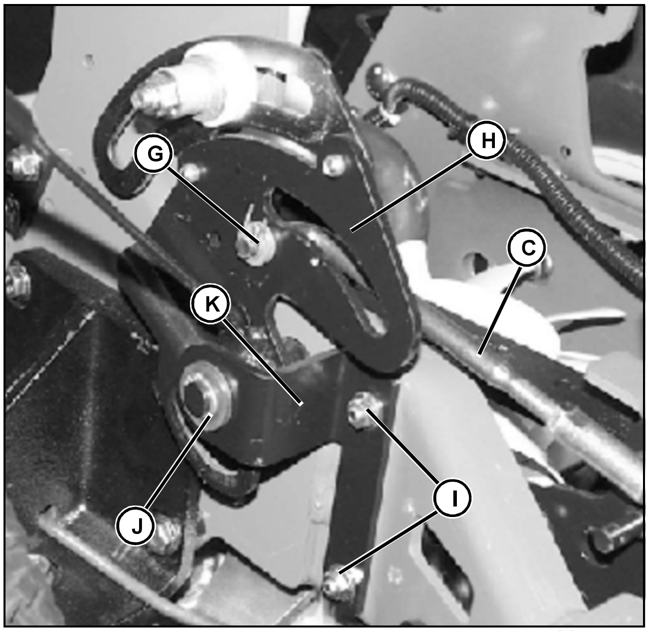
3. Remove locknut (B) attaching hand lever rod (C) to intermediate shaft plate (D).

IMPORTANT: Avoid damage! When removing friction device (F) and cruise control lever, note location and quantity of washers during removal to ensure correct reassembly.



M99700

4. Remove locknut (E) retaining friction device (F). Remove friction device.



M99700

5. Remove cotter pin and bushing (G) securing hand lever rod (C) to hand control lever (H). Disconnect hand lever rod from hand control lever.

6. Remove outer snap ring and washer (J) (two used) on hand control lever shaft.

7. Remove two nuts (I), two cap screws, and support bracket (K).

8. Remove inner snap ring and washer from hand control lever shaft. Remove hand control lever.

Installation:

Installation is the reverse of removal.

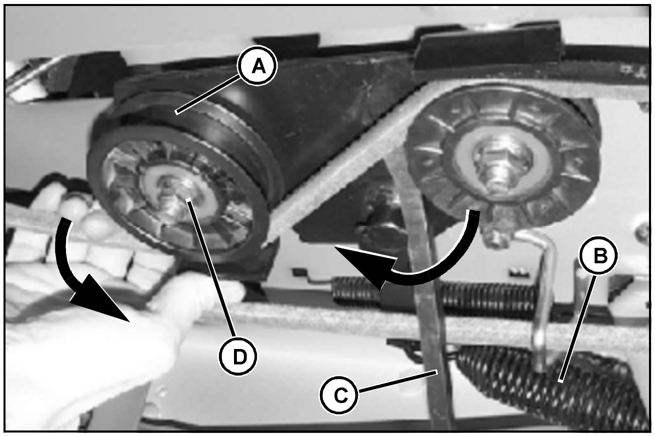
- When installation is complete, perform hand control lever friction adjustment and hand lever rod adjustment. See “Cruise/Hand Control Lever Tension Adjustment” on page 410 and “Hand Lever Rod Adjustment” on page 409.

Brake Pedal and Linkage

Removal:

1. Remove mower deck. See the appropriate Mower Deck Removal and Installation procedure in the Attachments section.

2. Remove fender deck. See “Fender Deck Removal and Installation” on page 590 in the Miscellaneous section.

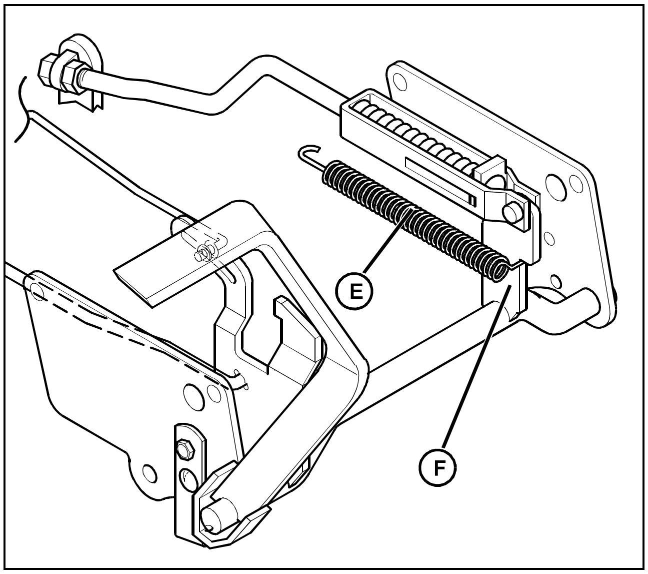


M99618

3. On underside of machine, locate the traction drive belt tensioner. Loosen nut (D) on flat idler (A).

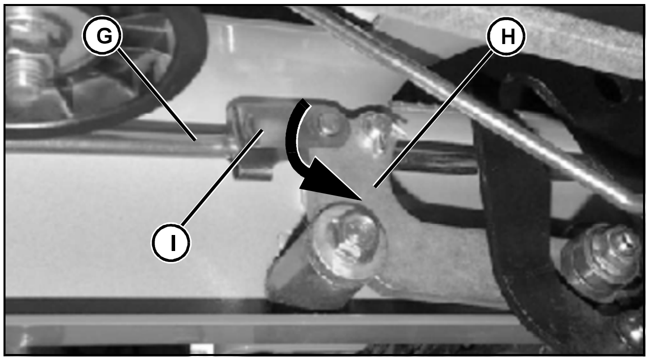
4. Using a pry bar (C), turn belt tensioner to relieve tension on belt, and slip belt off of flat idler.

5. Rotate tensioner assembly and remove spring (B).



MIF

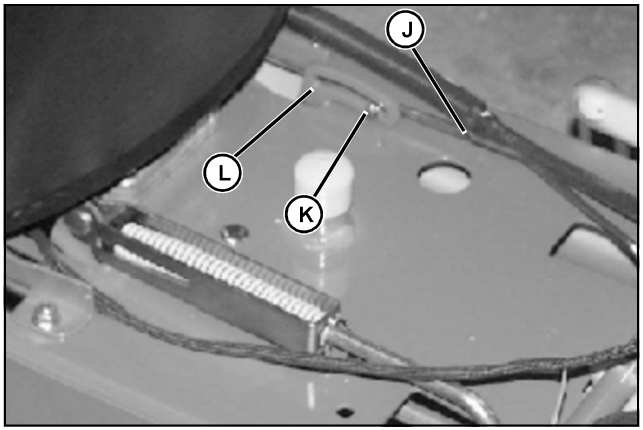
6. Using a suitable spring tool, disconnect brake return spring (E) from brake shaft arm (F).



M99608

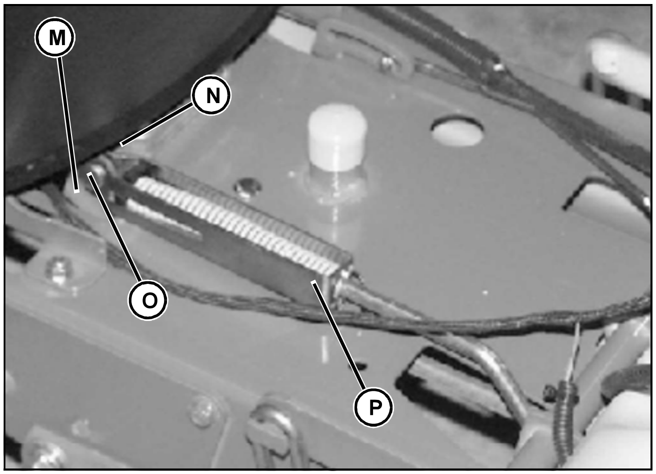
7. Rotate retainer (I) and disconnect neutral return rod (G) from neutral return arm (H).

8. Rotate neutral return rod 90° and remove from brake pedal arm.



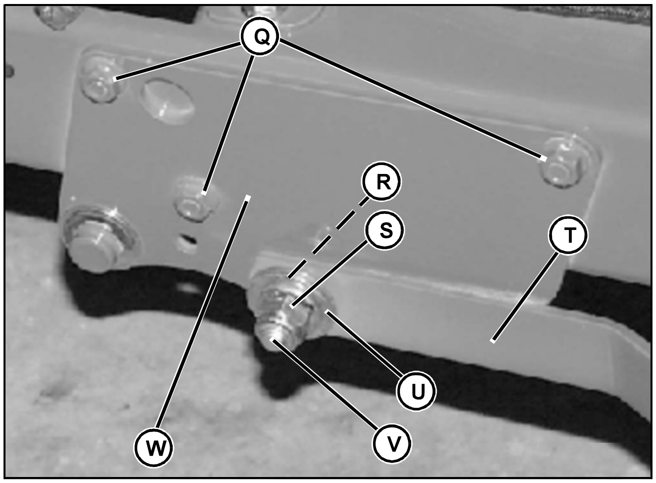
M99589

9. Remove cotter pin and washer (K), and disconnect freewheeling interlock rod (J) from brake pedal (L).



M99589

10.Remove cotter pin and washer (N), and clevis pin (O), and disconnect brake rod assembly (P) from brake pedal arm (M).



M99620

11.Remove lock nut (S), washer (U), spacer (R) and cap screw (V). Remove lift arm (T).

12.Repeat for other side.

13.Remove three nuts and carriage bolts (Q), and left brake shaft mounting plate (W).

14.Remove three nuts and carriage bolts, and right brake shaft mounting plate and brake pedal and shaft assembly.

15.Inspect components for wear or damage. Replace parts as needed.

Installation:

Installation is the reverse of removal.

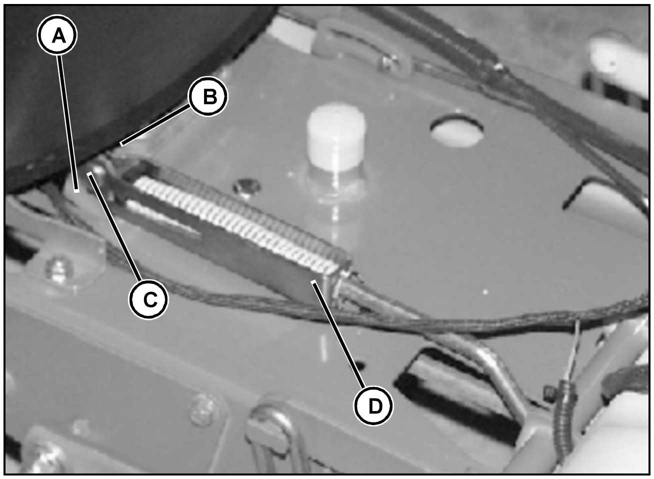
- Be sure to tighten flat idler sheave nut after reconnecting belt to idlers.
- When installation is complete, perform brake linkage adjustment procedure. See “Brake Linkage Adjustment” on page 410.

Brake Rod Removal and Installation

Removal:

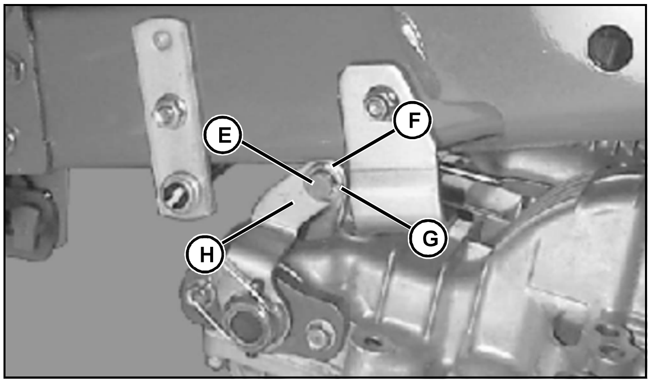
1. Remove mower deck. See the appropriate Mower Deck Removal and Installation procedure in the Attachments section.

2. Remove fender deck. See “Fender Deck Removal and Installation” on page 590 in the Miscellaneous section.



M99589

3. Remove cotter pin and washer (B), and clevis pin (C), and disconnect brake rod assembly (D) from brake pedal arm (A).



M95328

4. On left side of , remove cotter pin (G) and washer (F), and disconnect brake link (E) from control lever (H). Remove brake rod assembly.

5. Inspect components for wear or damage. Replace parts as needed.

Installation:

Installation is the reverse of removal.

- When installation is complete, perform brake linkage adjustment procedure. See “Brake Linkage Adjustment” on page 410.

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STEERING   TABLE OF CONTENTS

STEERING SPECIFICATIONS

Specifications

LX255, LX266, LX277, LX279 and LX288 2 Wheel Steering (2WS)

Torque Specifications:

Spindle axle pivot	65 N•m (48 lb-ft)
Steering support bolts	22 N•m (192 lb-in.)
Tie rod locknuts	60 N•m (44 lb-ft)
Drag link locknuts	60 N•m (44 lb-ft)
Steering wheel nut	Snug Only

Jam Nuts

M10	20 N•m (168 lb-in.)
M12	30 N•m (22 lb-ft)

Lubrication Interval:

Spindle grease fitting and kingpin	Every 25 hours (severe conditions)
	Every 50 hours (normal conditions)

Toe-In Adjustment:

Front-to-rear difference	front of wheel is 15 ± 5 mm (0.6 ± 0.2 in.) less than rear

LX277 and LX279 All Wheel Steering (AWS)

Torque Specifications:

Spindle axle pivot	65 N•m (48 lb-ft)
Steering support carriage bolt nuts	22 N•m (192 lb-in.)
Tie rod locknuts	60 N•m (44 lb-ft)
Drag link locknuts	60 N•m (44 lb-ft)
Steering wheel nut	Snug Only
Control strap front allen head screw	16 N•m (142 lb-in.)
Control strap to rear pivot	30 N•m (22 lb-ft)
Control arm to frame bolt	32 N•m (23 lb-ft)
Front pivot	32 N•m (23 lb-ft)

Jam Nuts

M10	20 N•m (168 lb-in.)
M12	30 N•m (22 lb-ft)

Transaxle fan nut	30 N•m (22 lb-ft)
Rear wheel bolts	55 N•m (41 lb-ft)

Engine mufflers

Kohler engine	20 - 25 N•m (168 - 204 lb-in.)
Kawasaki engines	6.9 N•m (61 lb-in.)

Lubrication:

Spindle grease fitting and kingpin	Every 25 hours (severe conditions)
	Every 50 hours (normal conditions)
Front axle	Grease spindles and center pivot

Rear axle . . . . Grease four places on casting

Toe-In Adjustment:

Front wheels Front-to-rear difference . . . . front of wheel is 15 ± 5 mm (0.6 ± 0.2 in.) less than rear
Rear wheels Front-to-rear difference . . . . front of wheel is 15 ± 1 mm (0.6 ± 0.04 in.) less than rear

Repair Specifications

Axle Beam Pivot Clearance (Maximum) . . . . 0.05 mm (0.002 in.)
Spindle Clearance (Maximum) . . . . 0.05 mm (0.002 in.)
Kohler Engine Muffler Cap Screws . . . . 20 - 25 N•m (168 - 204 lb-in.)
Kohler Engine Mounting Bolts . . . . 29 - 35 N•m (22 - 26 lb-ft)
Kawasaki Engine Muffler Nuts . . . . 6.9 N•m (61 lb-in.)
Briggs & Stratton Exhaust Manifold . . . . 17 N•m (150 lb-in.)

Tools and Materials

Service Equipment and Tools

Special or Required Tools

Tool Name	Tool No.	Tool Use
Inside Puller and Slide Hammer	- - -	Remove steering support needle bearings and front axle pivot bushings.

NOTE: Order tools from your SERVICE-GARD Catalog. Some tools may be available from a local supplier.

Other Materials

Other Material

Part No.	Part Name	Part Use
M79292	MPG-2® Multipurpose Grease	Lubricate Spindles
T43512 / TY9473 / 242	LOCTITE® Thread Lock and Sealer (Medium Strength)	Apply to threads of sheave set screws

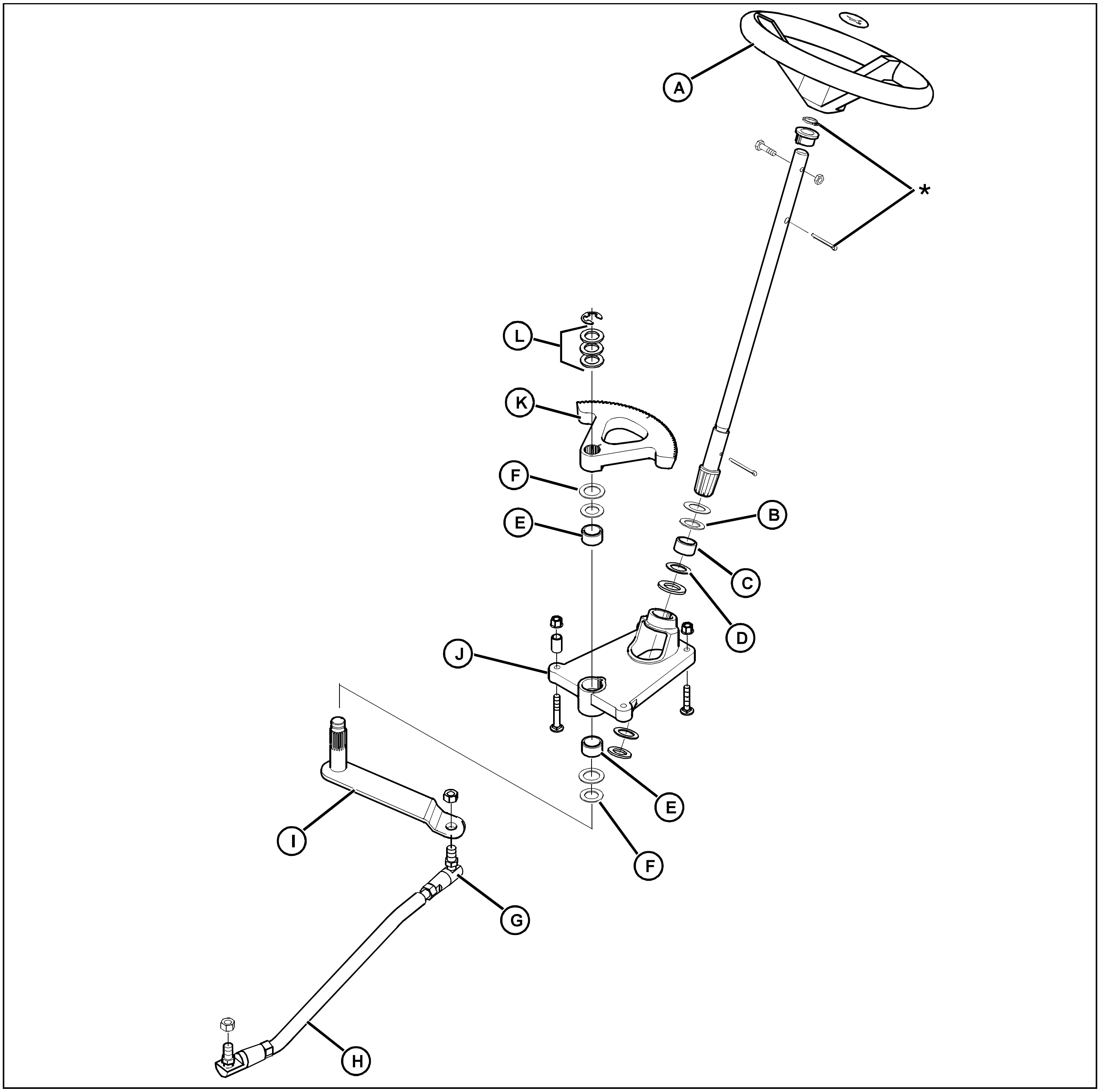
LOCTITE® is a registered trademark of the Loctite Corp.

MPG-2® is a registered trademark of DuBois USA

STEERING COMPONENT LOCATION

Component Location

Steering Wheel - 2WS

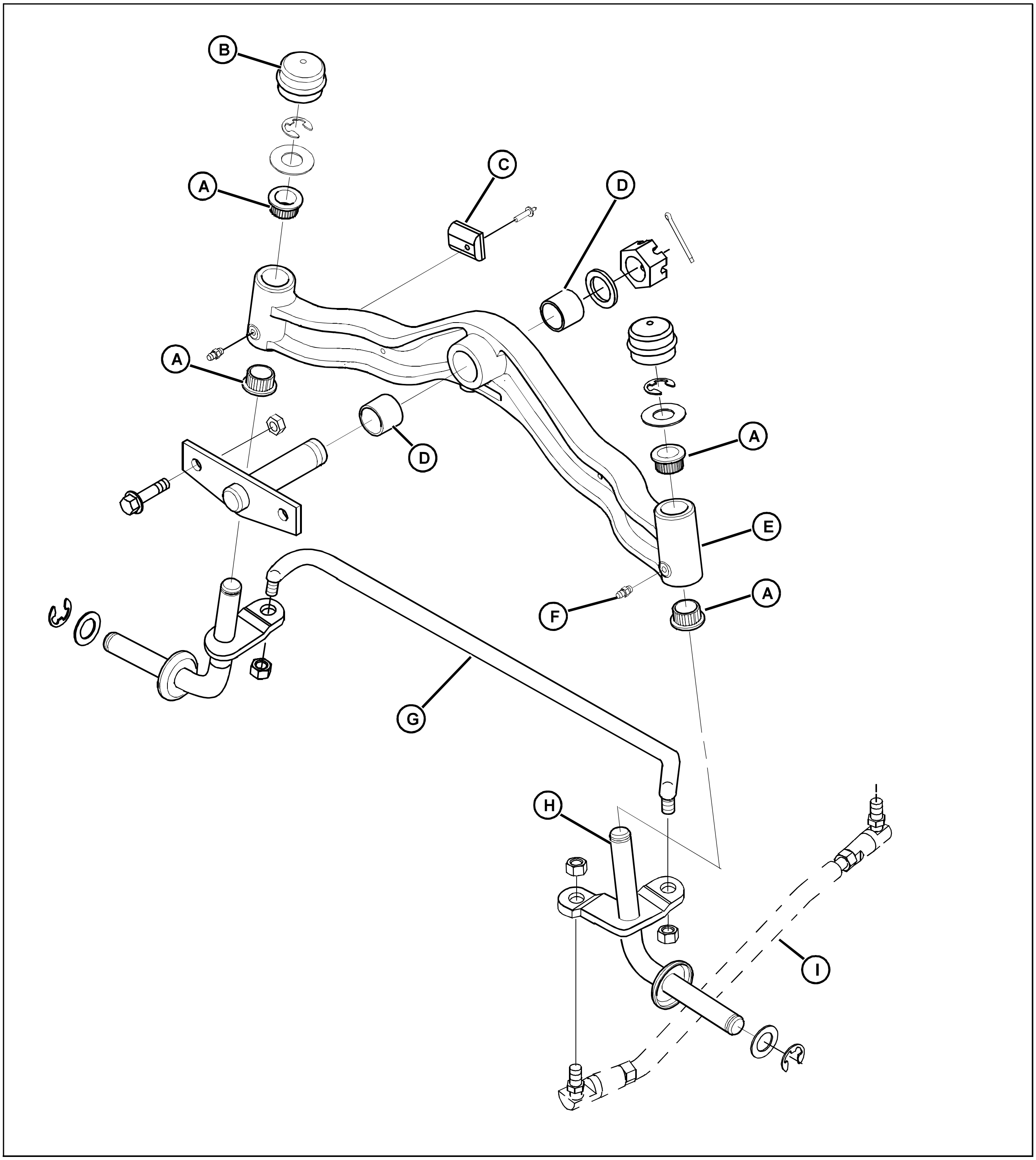


MIF

- **A - Steering Wheel**
- **B - Packing**
- **C - Needle Bearing**
- **D - Packing**
- **E - Needle Bearing**
- **F - Packing**
- **G - Ball Joint**
- **H - Drag Link**
- **I - Steering Arm**
- **J - Support**
- **K - Sector Gear**
- **L - Shim(s)**

* Early models have snap ring, later models have cotter pin.

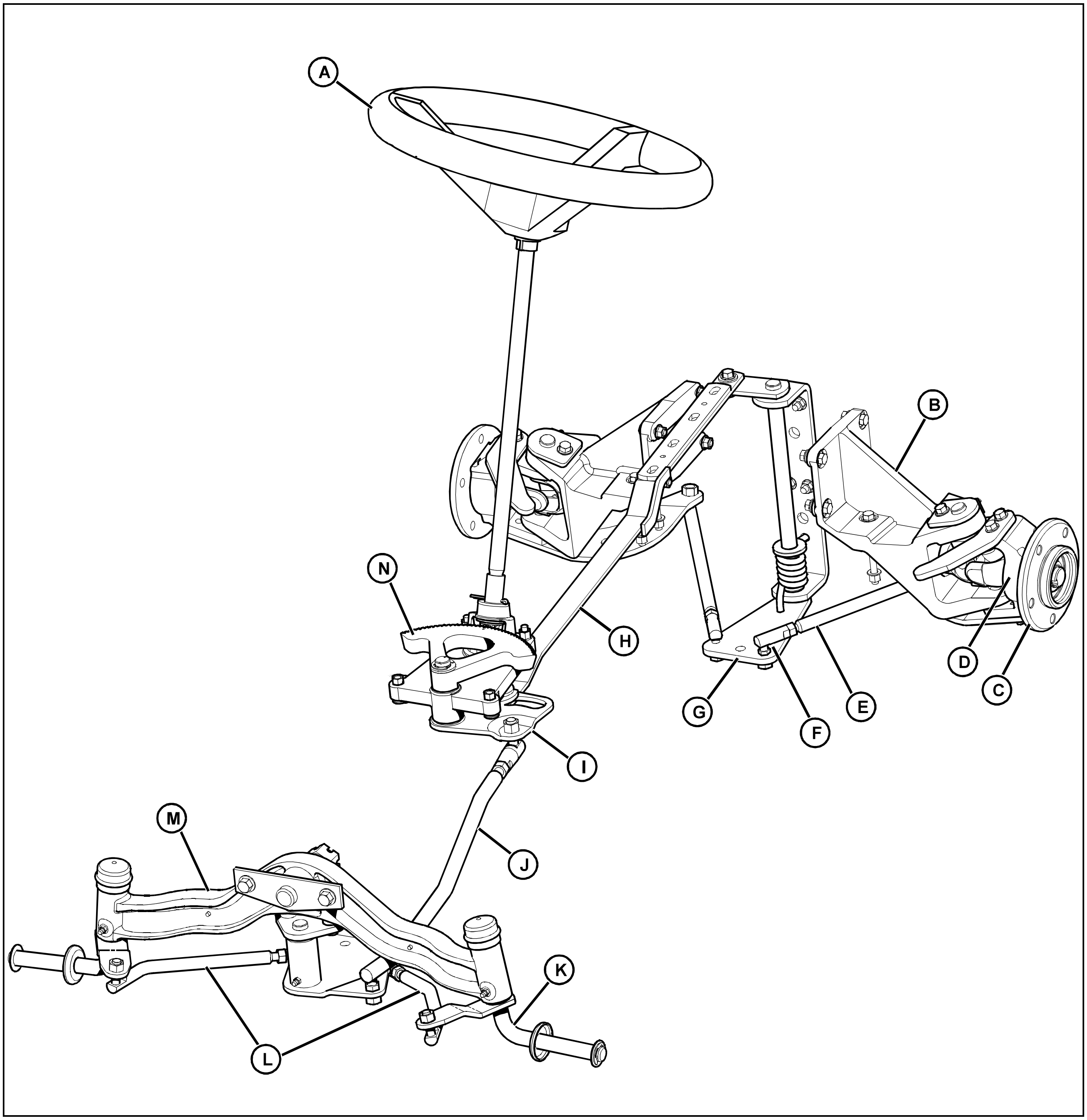
Front Axle - 2WS



MIF

A - Bearing
B - Cap
C - Pad
D - Bushing
E - Axle
F - Grease Fitting
G - Tie Rod
H - Spindle
I - Drag Link

Steering Components - AWS

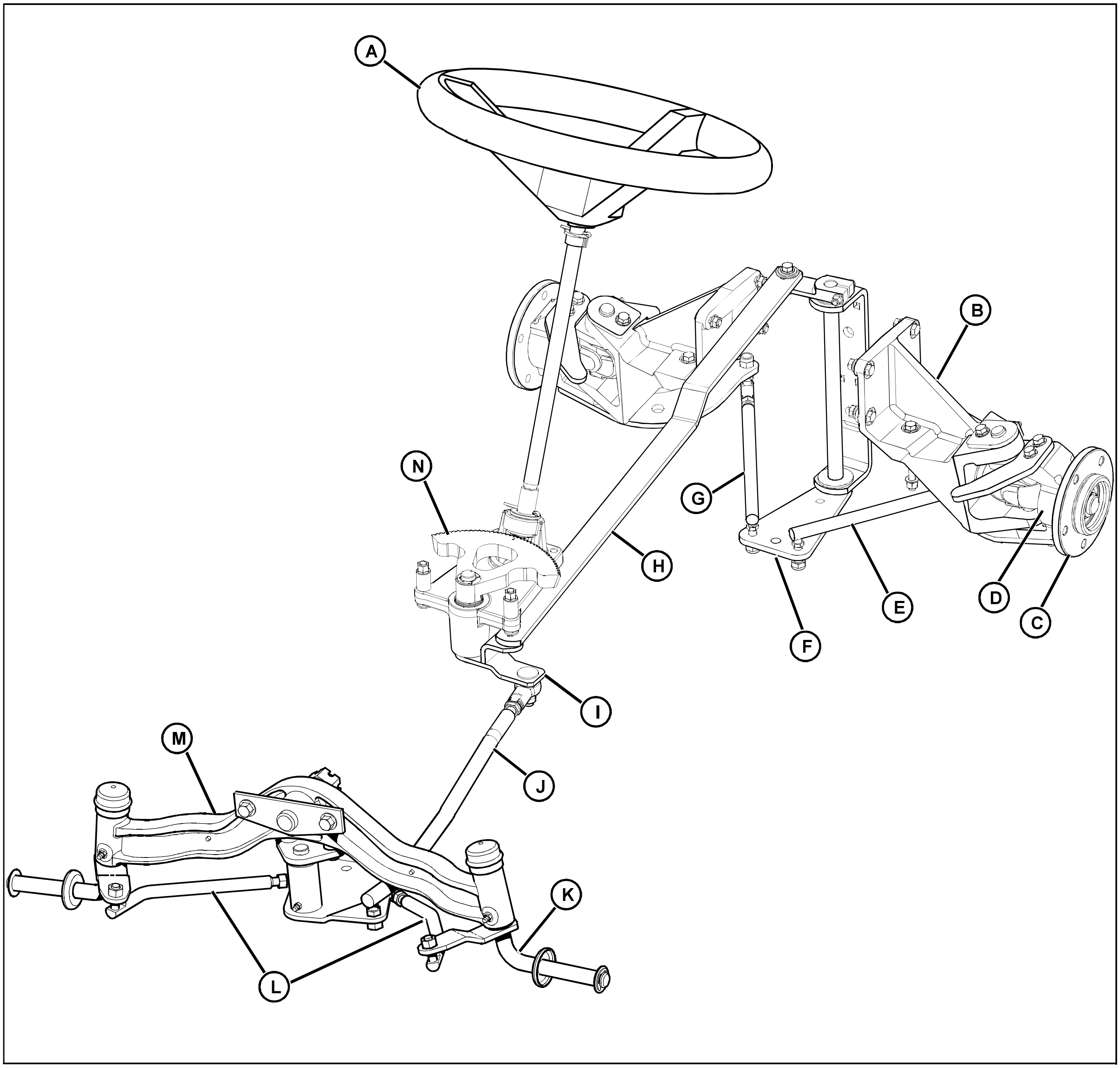


MIF

A - **Steering Wheel**
B - **Rear Axle Support**
C - **Hub**
D - **Pivot**
E - **Tie Rod**
F - **Ball Joint**
G - **Pivot**
H - **Control Strap**
I - **Steering Cam**
J - **Drag Link**
K - **Spindle**
L - **Tie Rod**
M - **Axle**
N - **Steering Gear**

Steering Components - LX277 AWS

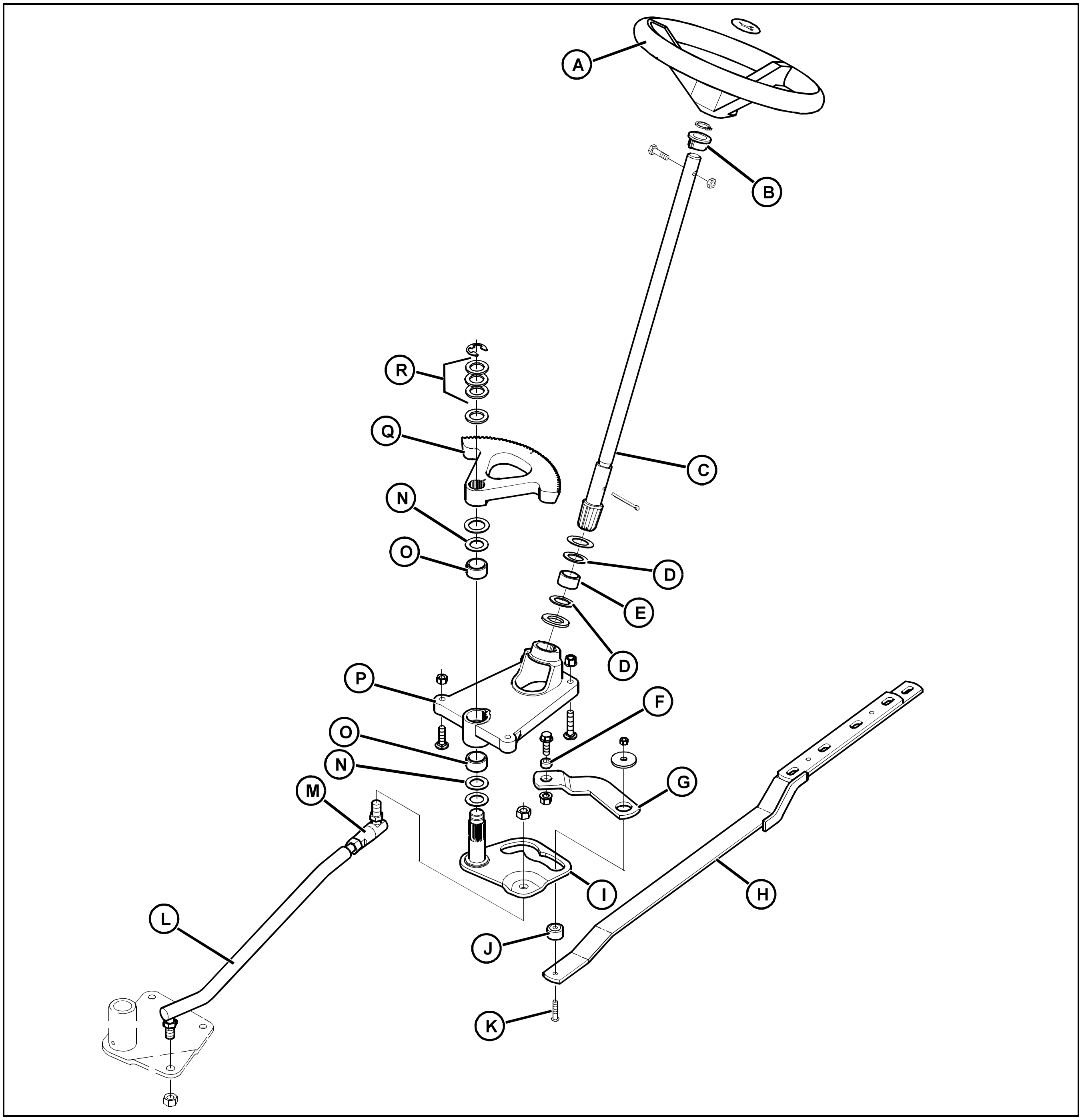
2002 Model Year (S/N 060001-)



MIF

- **A - Steering Wheel**
- **B - Rear Axle Support**
- **C - Hub**
- **D - Pivot**
- **E - Tie Rod**
- **F - Pivot**
- **G - Tie Rod**
- **H - Control Strap**
- **I - Sector Arm**
- **J - Drag Link**
- **K - Spindle**
- **L - Tie Rod**
- **M - Axle**
- **N - Steering Gear**

Steering Wheel - AWS

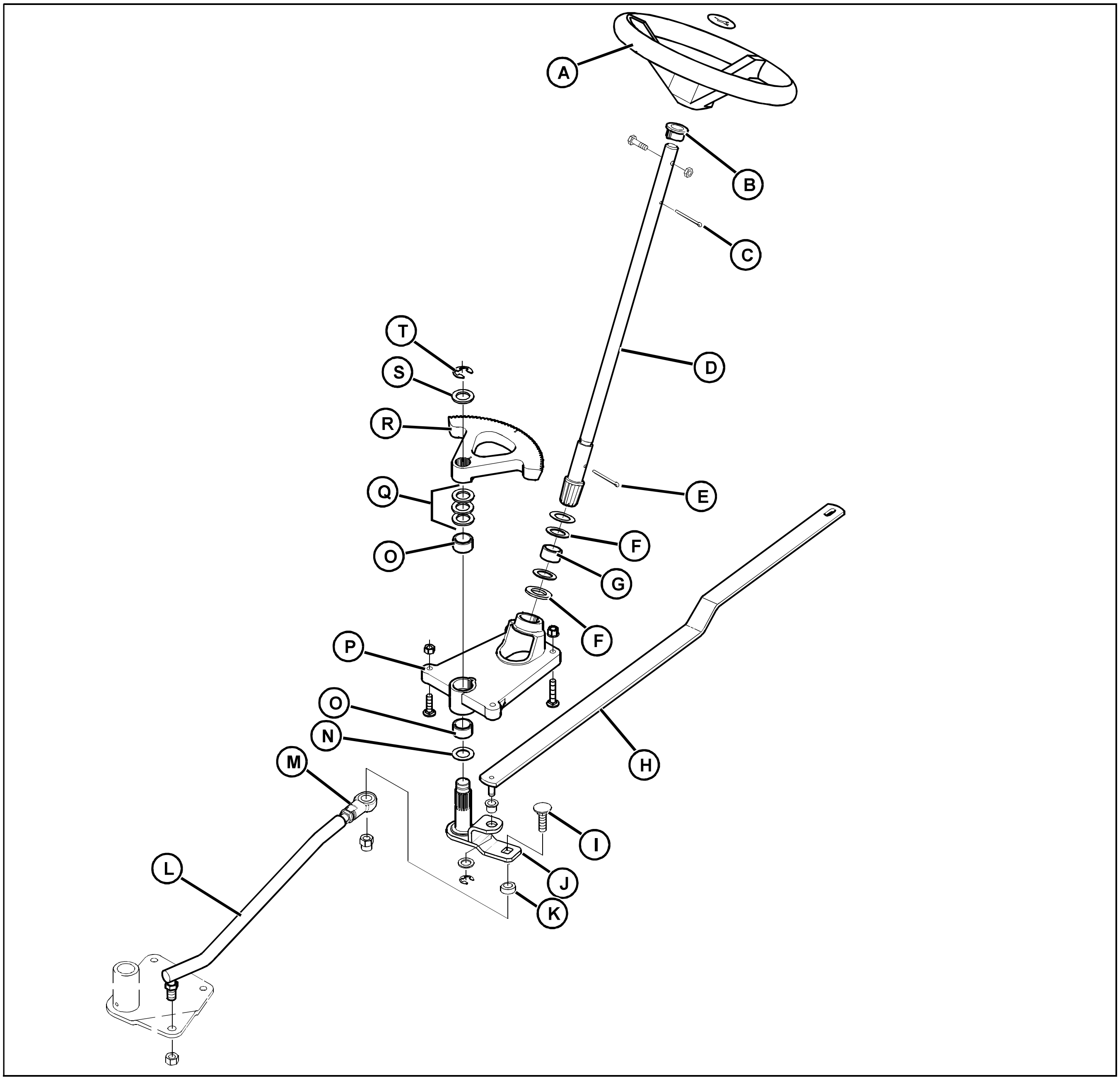


MIF

A - **Steering Wheel**
B - **Bushing**
C - **Steering Gear**
D - **Packing**
E - **Needle Bearing**
F - **Bushing**
G - **Control Arm**
H - **Control Strap**
I - **Steering Cam**
J - **Bearing**
K - **Screw**
L - **Drag Link**
M - **Ball Joint**
N - **Packing**
O - **Needle Bearing**
P - **Support**
Q - **Sector Gear**
R - **Shim(s)**

Steering Wheel - LX277 AWS

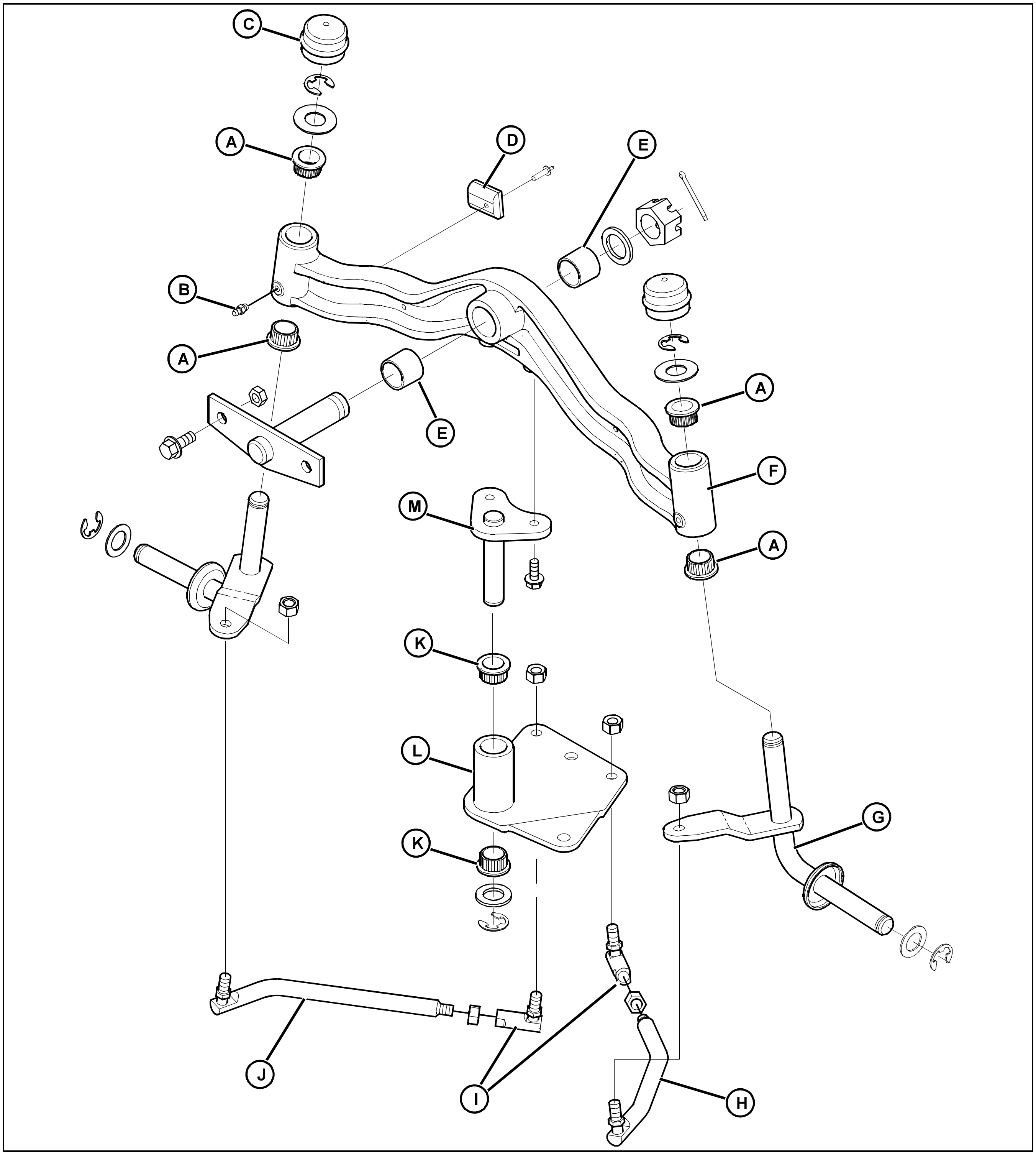
2002 Model Year (S/N 060001-)



MIF

A - Steering Wheel
B - Bushing
C - Cotter Pin
D - Steering Gear
E - Cotter Pin
F - Packing
G - Needle Bearing
H - Control Strap
I - Carriage Bolt
J - Sector Arm
K - Bushing
L - Drag Link
M - Ball Joint
N - Washer
O - Bearing
P - Support
Q - Washer (3)
R - Sector Gear
S - Washer
T - E-Clip

Front Axle - AWS


C
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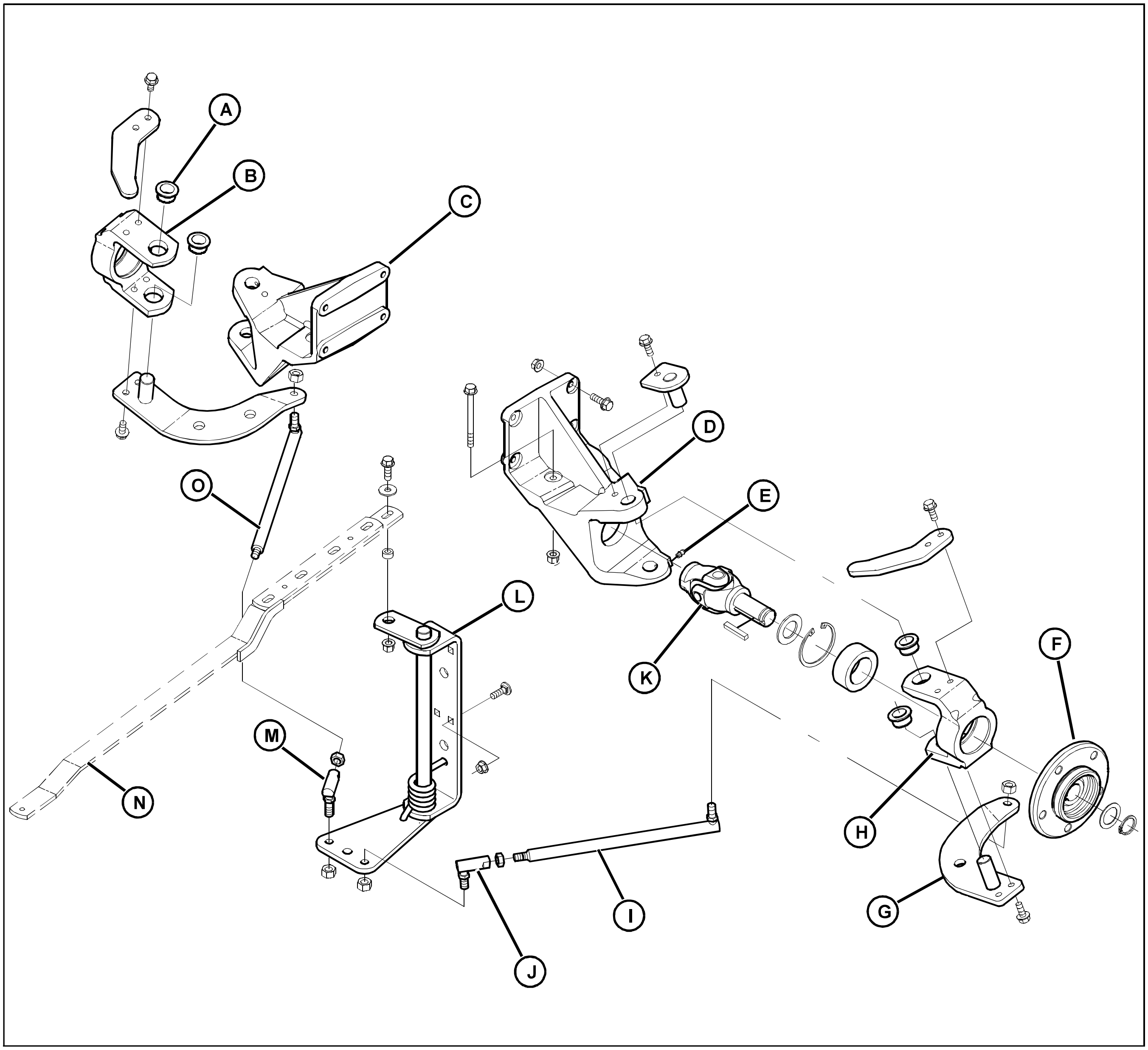
MIF

A - Bearing
B - Grease Fitting
C - Cap
D - Pad
E - Bushing
F - Axle
G - Spindle
H - Tie Rod
I - Ball Joint
J - Tie Rod
K - Bearing
L - Front Pivot Plate
M - Pivot

Rear Axle and Tie Rods - AWS

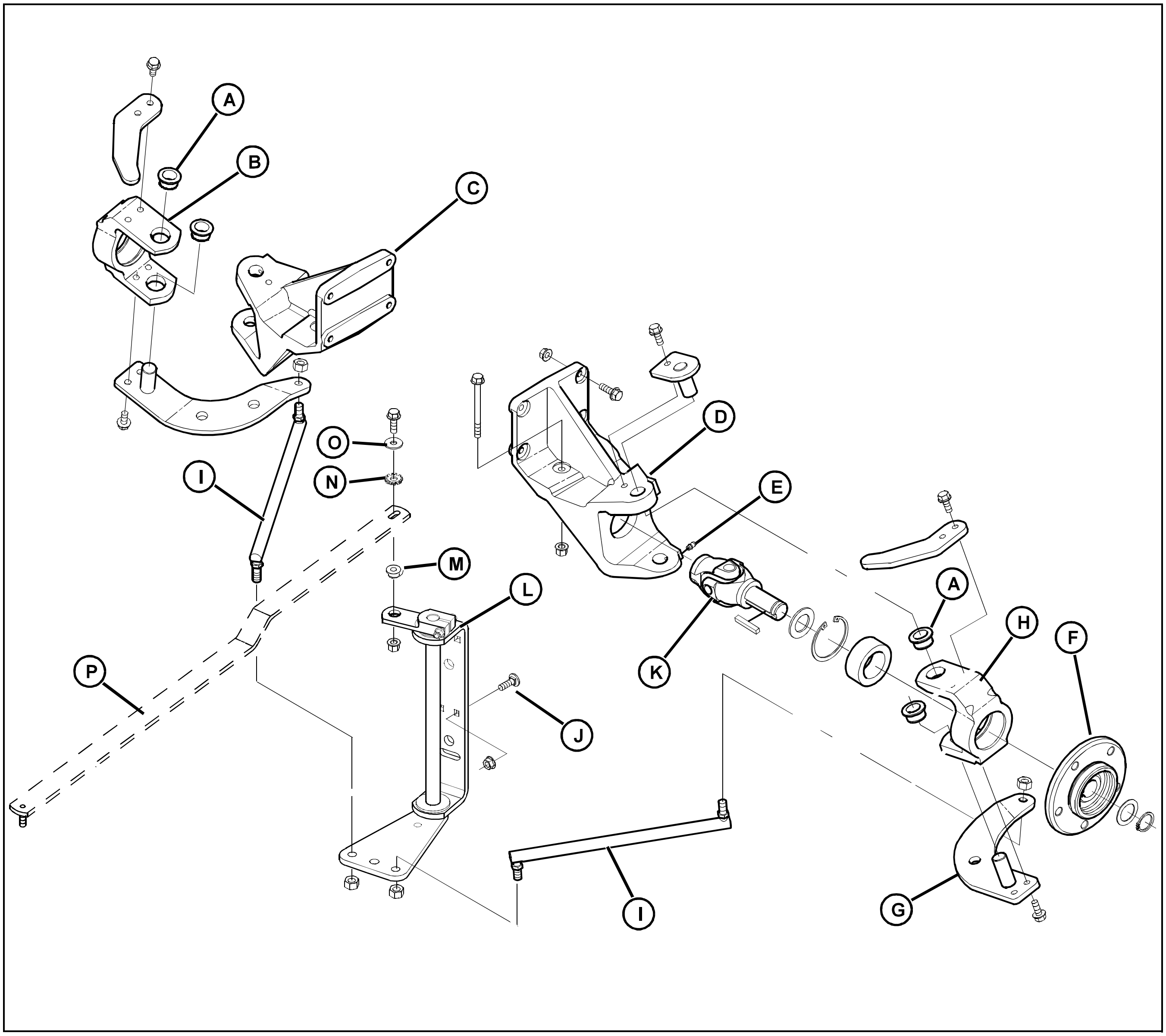


MIF

- **A - Bushing**
- **B - Pivot**
- **C - Rear Axle Support**
- **D - Rear Axle Support**
- **E - Grease Fitting**
- **F - Hub**
- **G - Spindle**
- **H - Pivot**
- **I - Tie Rod**
- **J - Ball Joint**
- **K - Universal Joint**
- **L - Pivot**
- **M - Ball Joint**
- **N - Control Strap**
- **O - Tie Rod**

Rear Axle and Tie Rods - LX277 AWS

2002 Model Year (S/N 060001-)



MIF

- **A** - Bushing
- **B** - Pivot
- **C** - Rear Axle Support
- **D** - Rear Axle Support
- **E** - Grease Fitting
- **F** - Hub
- **G** - Spindle
- **H** - Pivot
- **I** - Tie Rod
- **J** - Carriage Bolt
- **K** - Universal Joint
- **L** - Pivot
- **M** - Bushing
- **N** - Star Washer
- **O** - Washer
- **P** - Control Strap

Theory of Operation

Steering System - 2WS

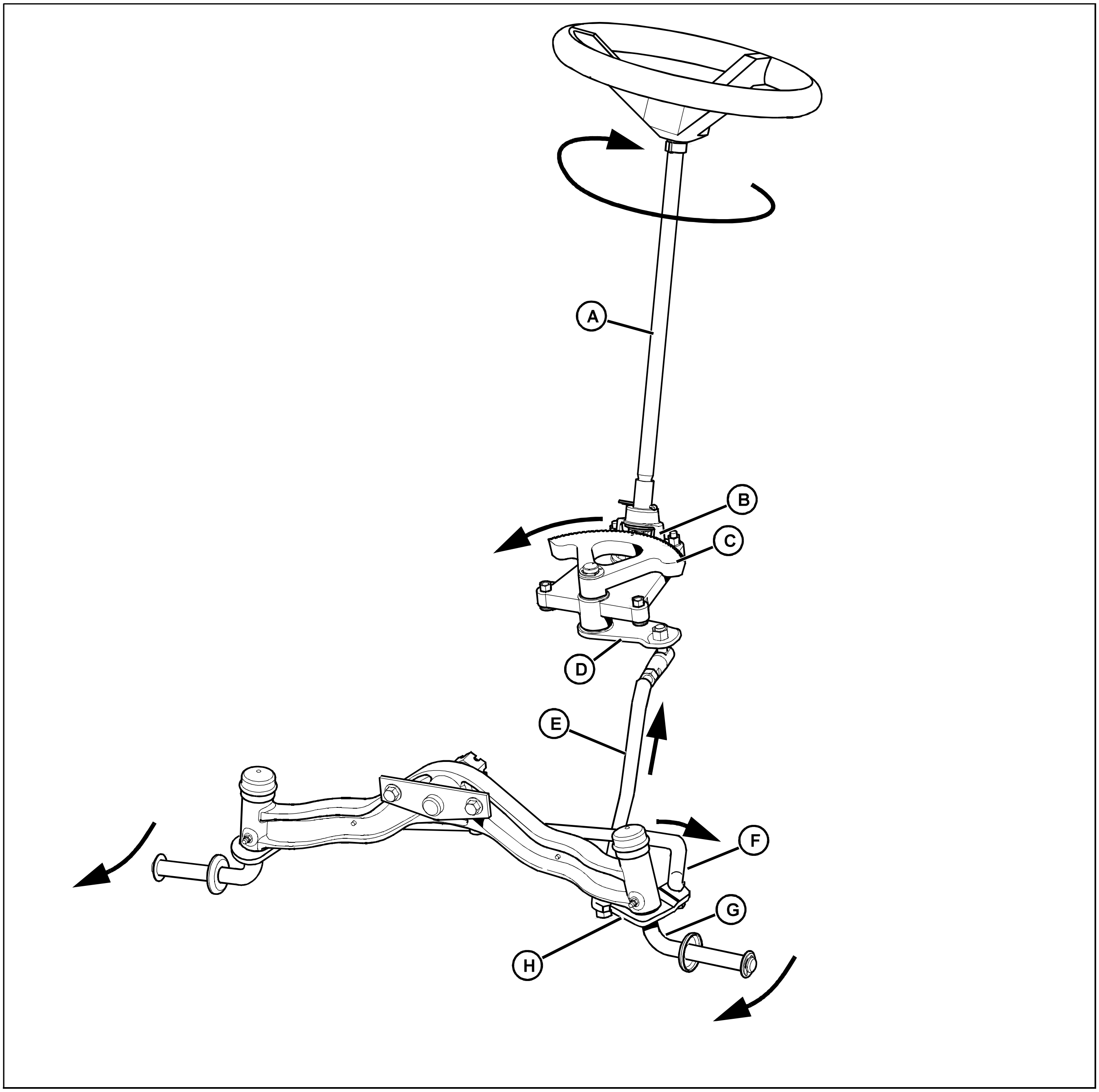
Function:

To allow the operator to change travel direction.

Theory of Operation:

As the steering wheel is turned, the steering shaft (A) and gear rotate. The steering gear (B) meshes with the sector gear (C), causing the sector gear and steering arm to rotate (D).

As the steering arm moves, the drag link (E) is moved (forward - left turn, backward - right turn) causing the left spindle to rotate. Since the spindles (G) are connected by the tie rod (F), both spindles are turned at the same time (attached to the front pivot (H)).



MIF

Steering System - AWS

Function:

To allow the operator to change travel direction. The All Wheel Steering turns the rear wheels in the opposite direction of the front wheels allowing a tighter turning radius.

Theory of Operation - Front Wheels:

As the steering wheel (A) is turned, the steering shaft and gear rotate. The steering gear (J) meshes with the sector gear, causing the sector gear and steering cam to rotate.

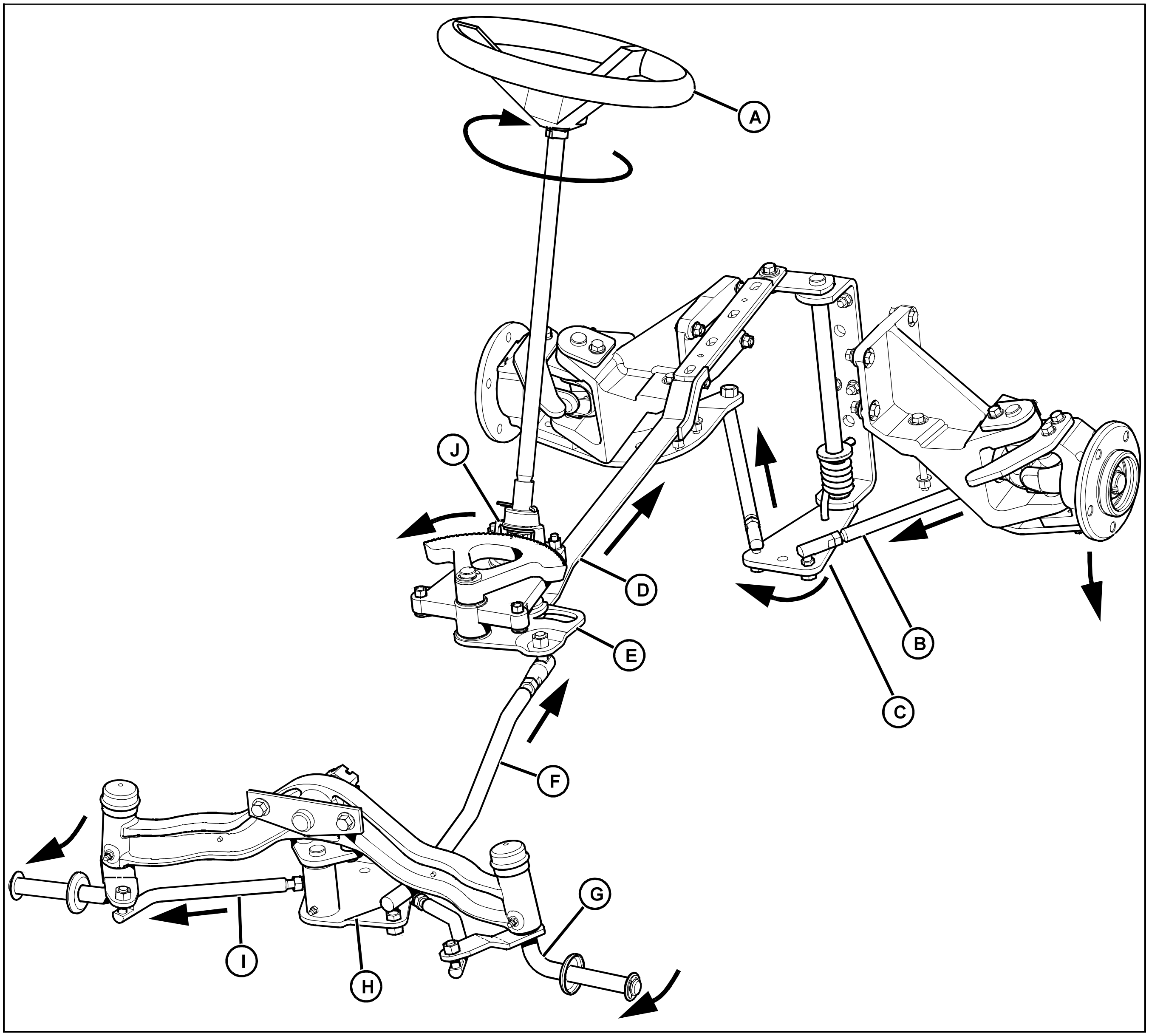
As the steering cam (E) moves, the drag link (F) is moved (backward - right turn, forward - left turn) causing the front pivot (H) to rotate. The two front tie rods (I) are connected to the front pivot. Since the spindles (G) are connected to the tie rods, both spindles are turned at the same time.

Theory of Operation - Rear Wheels:

As the steering wheel is turned, the steering shaft and gear rotate. The steering gear meshes with the sector gear, causing the sector gear and steering cam to rotate.

As the steering cam moves, the control strap (D) is moved (forward - left turn, backward - right turn) causing the rear pivot (C) to rotate. The two rear tie rods are connected to the rear pivot. Since the rear spindles are connected to the rear tie rods (B), both spindles are turned at the same time.

NOTE: Turning the steering wheel to the right (clockwise - shown below) turns the front wheels to the right and the rear wheels to the left.



MIF

Diagnostics

Steering System - Front Steering

NOTE: Before checking for a steering problem, make sure that tire inflation is correct.

Test Conditions:

- Machine parked on level surface.
- Parking brake LOCKED.
- Front axle raised safely off ground.
- Key switch in OFF position.

Test/Check Point	Normal Condition	If Not Normal
1. Front wheel bushings	Wheels rotate freely without feeling rough spots.	Check front wheel bushings and lubrication.
2. Spindles	Spindles move freely without feeling rough spots.	Check axle spindle holes and lubrication.
3. Front axle	Not binding, damaged, or worn. Axle pivots freely.	Adjust drag link. Check bushings in center of axle.
4. Tie rod(s)	Not binding, damaged, bent, or worn.	Replace tie rod(s).
5. Gear and sector assembly	Teeth not worn or damaged. Not binding.	Replace gear and sector assembly. Check bearings.
6. Drag link and steering arm	Not binding, damaged or worn.	Replace linkage.

Steering System - Rear Steering

NOTE: Before checking for a steering problem, make sure that tire inflation is correct.

Test Conditions:

- Machine parked on level surface.
- Parking brake LOCKED.
- Rear axle raised safely off ground.
- Key switch in OFF position.

Test/Check Point	Normal Condition	If Not Normal
1. Rear wheel bearings	Wheels rotate freely without feeling rough spots.	Check rear wheel bearings and lubrication.
2. Spindles	Spindles move freely without feeling rough spots.	Check spindle lubrication. Check universal joint.
3. Rear axle pivot	Not binding, damaged, or worn.	Check ball joints. Replace tie rod.
4. Tie rods	Not binding, damaged, bent, or worn.	Check ball joints. Replace tie rod(s).
5. Universal joint	Rotates and flexes freely. Not binding.	Check axle key for shearing. Replace universal joint.

Steering Wander

Test Conditions:

- Machine parked on level surface.
- Parking brake LOCKED.
- Front axle raised safely off ground.
- Key switch in OFF position.

Test/Check Point	Normal Condition	If Not Normal
1. Gear and sector assembly	Teeth not worn or damaged. Not binding.	Replace gear and sector assembly. Check bushings. See “Steering Gear Removal” on page 474.
2. Tie rod(s)	Not binding, damaged, bent, or worn.	Replace tie rod.

Lash (Lost Motion) at Steering Wheel

Test Conditions:

- Machine parked on level surface.
- Parking brake LOCKED.
- Front axle raised safely off ground.
- Key switch in OFF position.

Test/Check Point	Normal Condition	If Not Normal
1. Steering wheel	Wheel securely mounted to shaft.	Tighten.
2. Steering linkage	Linkage not loose, worn or damaged.	Tighten, repair or replace linkage.
3. Gear and sector assembly	Teeth not worn or damaged. Not binding.	Replace gear and sector assembly. Check bushings. See “Steering Gear Removal” on page 474.
4. Tie rod(s)	Not binding, damaged, bent, or worn.	Replace tie rod(s).

Steering Wheel Turns Farther In One Direction

Test Conditions:

- Machine parked on level surface.
- Parking brake LOCKED.
- Front axle raised safely off ground.
- Key switch in OFF position.

Test/Check Point	Normal Condition	If Not Normal
1. Drag link	Drag link properly adjusted.	Adjust drag link. See “Steering Wheel Centering” on page 471.

Test/Check Point	Normal Condition	If Not Normal
2. Gear and sector assembly	Teeth not worn, damaged or misaligned.	Check gear tooth alignment. Replace gear and sector assembly.

Wheels Will Not Track Straight

Test Conditions:

- Machine parked on level surface.
- Parking brake LOCKED.
- Front axle raised safely off ground.
- Key switch in OFF position.

Test/Check Point	Normal Condition	If Not Normal
1. Tie rod(s)	Tie rod(s) properly adjusted, not bent or damaged.	Adjust tie rod(s). See “Toe-In Adjustment - AWS Rear” on page 472. Replace bent or damaged components.

Tests and Adjustments

Toe-In Adjustment - AWS Front

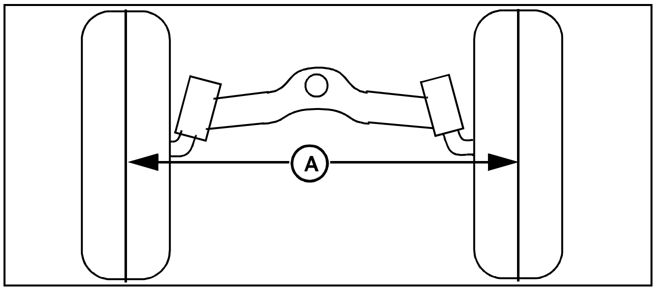
Purpose:

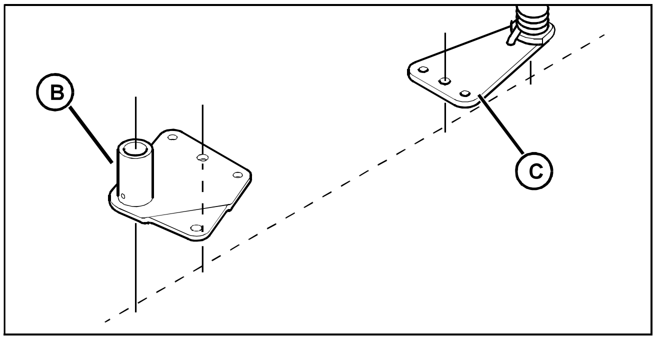
To adjust the tires so there is a 15 ± 5 mm (0.59 ± 0.20 in.) positive toe-in. The front center “bead” of the tires should be closer together than the rear center “bead” of the tires. Correct toe-in adjustment prevents tire wear and steering wander.

Procedure:

1. Park machine on a level surface. Turn key switch OFF, and lock parking brake.
2. Put wheels in a straight forward position.

NOTE: A straight forward position can be obtained visually. Place a bolt through the center hole in the front pivot plate (B) and align the bolt with the center line of the machine (center of rear pivot plate (C).





All holes and pivots should visually line up

3. Measure the distance between the center tread “bead” lines (A) on the front of the wheels.
4. Measure the distance between the center tread "bead" lines on the rear of the wheels.

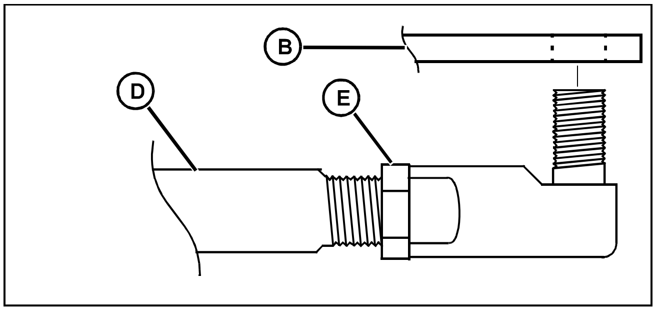
Results:

The difference between the measurements (rear dimension minus front dimension) should be the 15 ± 5 mm (0.59 ± 0.04 in.). If not, the toe-in should be adjusted.

To Adjust Toe-In:

1. Count the number of exposed threads by the jam nut of the tie rod.

NOTE: Factory preset is approximately eight threads exposed on the front tie rods. The exposed thread count should be approximately the same for left and right tie rods.



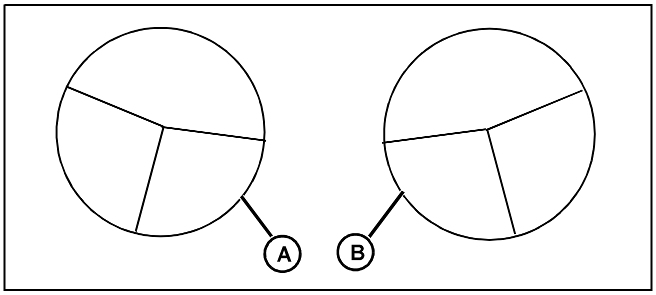
2. Remove locknuts securing tie rod (D) ball joint to front pivot plate (B).
3. While holding ball joint to prevent turning, loosen jam nut (E).
4. Adjust tie rod end(s) to achieve the specified toe-in.
5. Insert ball joints into front pivot plate and secure with locknuts. Tighten locknuts to 60 N•m (44 lb-ft).
6. Remeasure toe-in on front wheels. If toe-in is correct, tighten tie rod jam nuts to 20 N•m (180 lb-in.).

Steering Wheel Centering

Purpose:

Proper steering wheel centering ensures steering wheel is centered when front wheels are in a straight forward position.

1. Drive the machine in a straight line and note whether the steering wheel is straight, rotated left or rotated right.
2. Adjust drag link to align the steering wheel.

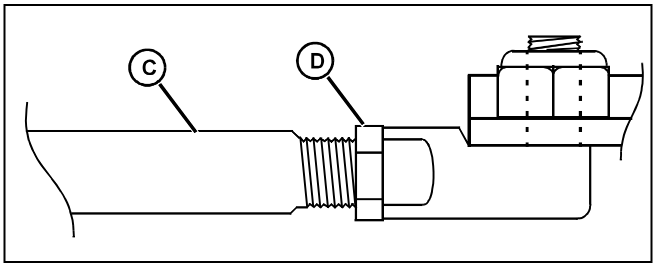


- If the steering wheel is left (A) when the front tires are straight forward, lengthen the drag link. See “To Adjust Draglink:” below.

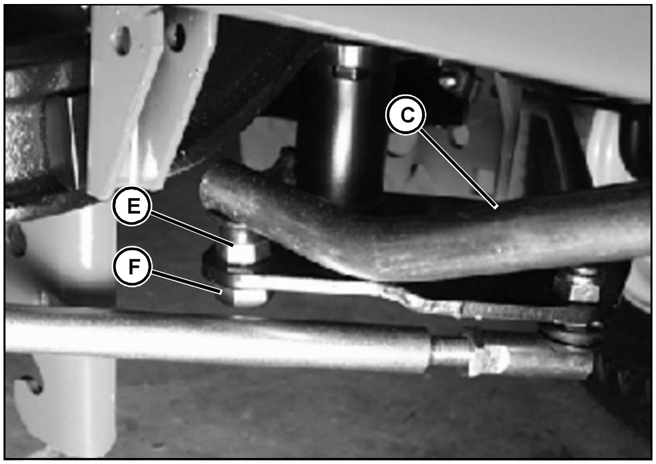
- If the steering wheel is right (B) when the front tires are straight forward, shorten the drag link. See “To Adjust Draglink:” below.

To Adjust Drag Link:

1. Turn steering wheel to right to expose front end of drag link.



2. While holding ball joint (on rear end of drag link (C)) to prevent turning, loosen jam nut (D).



AWS Drag Link Shown

3. Disconnect front end of drag link (C).
   - While holding the top nut (E) to prevent it from rotating, remove the lower nut (F) securing the front end of the drag link to the front pivot plate.
   - While holding ball joint (on rear end of drag link) to prevent turning, turn drag link to shorten or extend its length.
     - If the steering wheel is left when the front tires are straight forward, lengthen the drag link.
     - If the steering wheel is right when the front tires are straight forward, shorten the drag link.
4. Move steering wheel until the ball joint slips easily into the steering cam.
5. Secure ball joint with locknut. Tighten jam nut to 60 N•m (44 lb-ft).
6. While holding ball joint (on rear end of drag link) to prevent turning, tighten jam nut to 30 N•m (22 lb-ft).

Toe-In Adjustment - AWS Rear

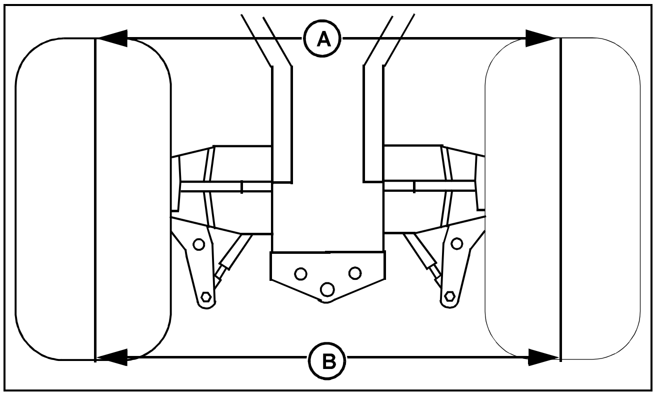
Purpose:

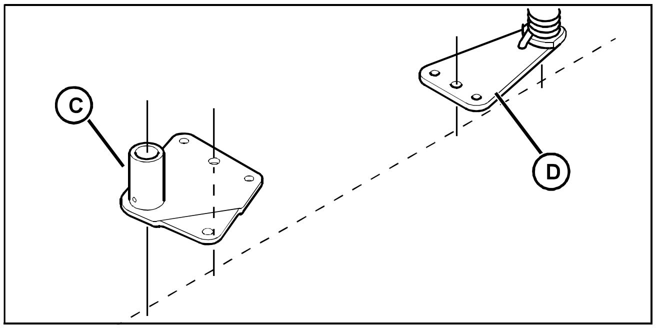
To adjust the tires so there is a 15 ± 5 mm (0.59 ± 0.20 in.) positive toe-in. The front center “bead” of the rear tires should be closer together than the rear center “bead” of the tires. Correct toe-in adjustment prevents tire wear and steering wander.

Procedure:

1. Park machine on a level surface. Turn key switch OFF, and lock parking brake.
2. Put front and rear wheels in a straight forward position.

NOTE: A straight forward position can be obtained visually. Place a bolt through the center hole in the front (C) and rear (D) pivot plates and align the bolts with the center line of the machine.





All holes and pivots should visually line up

3. Measure the distance between the center tread “bead” lines on the front (A) of the rear wheels.
4. Measure the distance between the center tread “bead” lines on the rear (B) of the rear wheels.

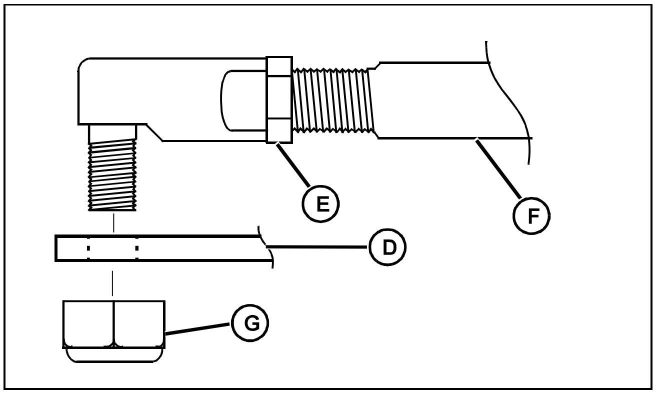
Results:

The difference between the measurements (rear dimension minus front dimension) should be the 15 ± 5 mm (0.59 ± 0.20 in.). If not, the toe-in should be adjusted. See “To Adjust Toe-In:” below.

To Adjust Toe-In:

1. Count the number of exposed threads by the jam nut of the tie rod.

NOTE: Factory preset is approximately twelve threads exposed on the rear tie rods. The exposed thread count should be approximately the same for left and right tie rods.



MIF

2. Remove locknuts (G) securing tie rod (F) ball joints to rear pivot plate (D).
3. While holding ball joint to prevent turning, loosen jam nut (E). Repeat for other side ball joint.
4. Adjust tie rod end(s) to achieve the specified toe-in.
5. Insert ball joints into rear pivot plate and secure with locknuts. Tighten locknuts to 60 N•m (44 lb-ft).
6. Remeasure toe-in on rear wheels. If toe-in is correct, tighten tie rod jam nuts to 20 N•m (180 lb-in.).

Rear Wheel Alignment - AWS

Purpose:

To adjust rear wheels so they are parallel with front wheels. Correct alignment prevents tire wear and rear wheel "crabbing".

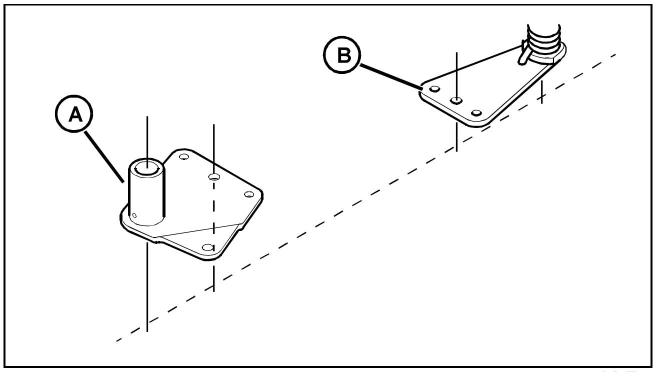
Procedure:

Adjustment of front and rear wheel toe-in should be performed before proceeding.

1. Park machine on a level surface. Turn key switch OFF, and lock parking brake.
2. Put steering wheel and front wheels in a straight forward position. Use either method below.

Method 1:

1. A straight forward position can be obtained visually.



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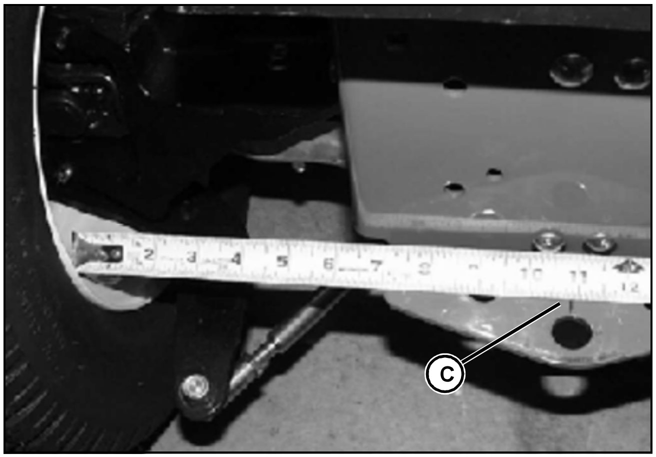
All holes and pivots should visually line up

- Place a bolt through the center hole in the rear pivot plate (B) and align the bolt with the center line of the machine (center of the front pivot plate (A)).

Method 2:



M95633

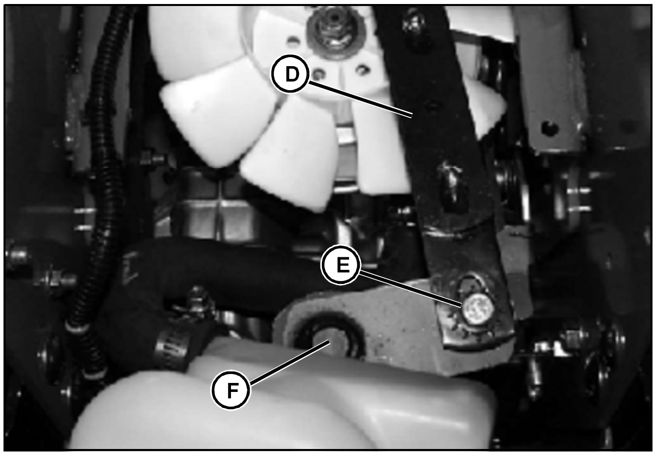
1. Place a mark (C) on center of the rear hitch.
2. Measure from the rim of the left wheel to the center mark. Measure from the rim of the right wheel to the center mark.

The measured distance from each wheel rim to the center mark should be equal.

If the measurements are not equal perform the following procedures in order.

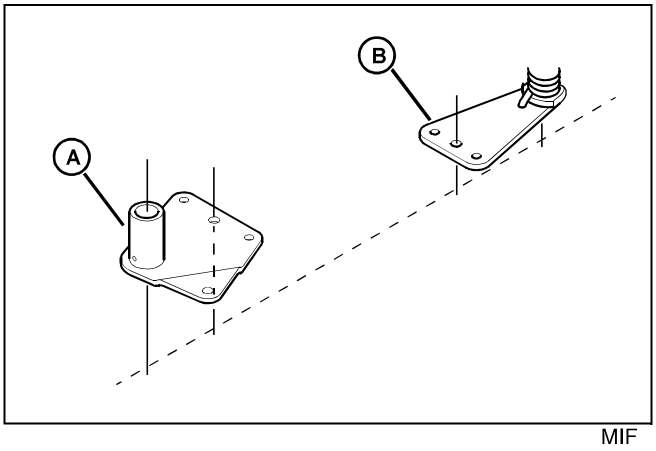
- Ensure steering wheel and front wheels are straight forward.
- Ensure toe-in of rear wheels is set correctly. See “Toe-In Adjustment - AWS Rear” on page 472.
- Adjust rear wheel alignment. See "To Align Rear Wheels:" below.

To Align Rear Wheels:



Fender Deck and Fuel Tank Removed for Clarity

1. Loosen bolt and nut (E) securing control strap (D) to rear pivot (F).
2. Turn rear wheels until the distance from the inside edge of rear wheel rims to the center mark on the rear hitch is equal.
3. Ensure front wheels are still aligned straight ahead. Confirm all holes in rear pivot plate (B) and front pivot plate (A) line up.



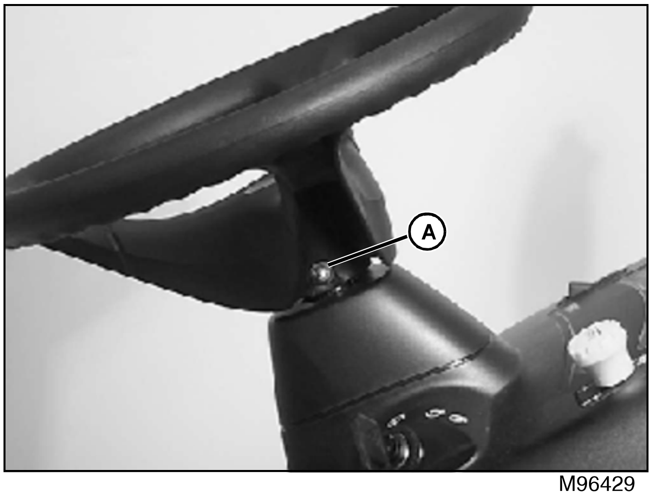
All holes and pivots should visually line up

4. Tighten the bolt and nut securing the control strap to the rear pivot.

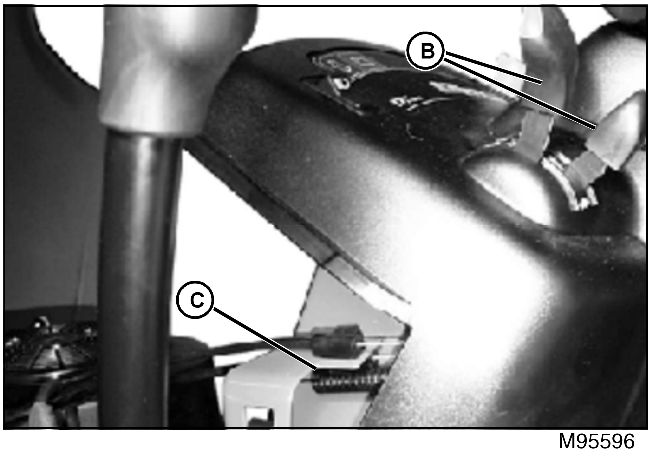
Repair

Steering Gear Removal

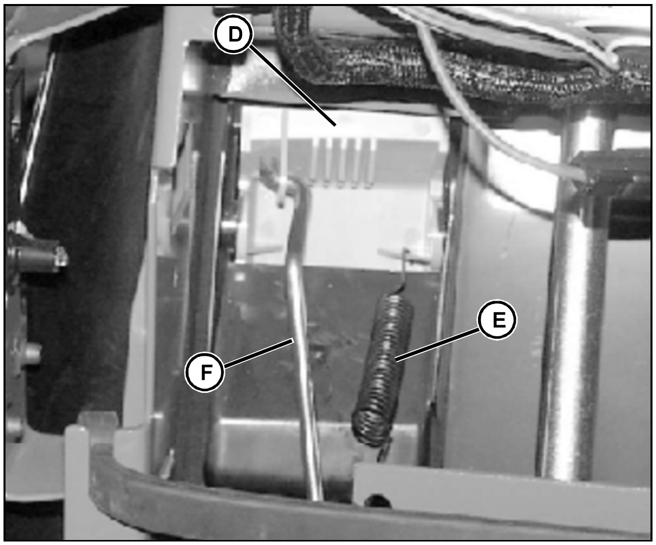
1. Remove battery.
2. Remove mower deck. See Mower Deck Removal and Installation for the appropriate deck in the Attachments section.



3. Remove locknut (A) and bolt securing steering wheel. Remove steering wheel.
4. Remove fender deck. See “Fender Deck Removal and Installation” on page 590 in the Miscellaneous section.
5. Remove pedestal left and right closeout panels, and loosen side screws securing pedestal to frame.



6. Remove choke cable return spring (C).
7. Remove choke and throttle control knobs (B).

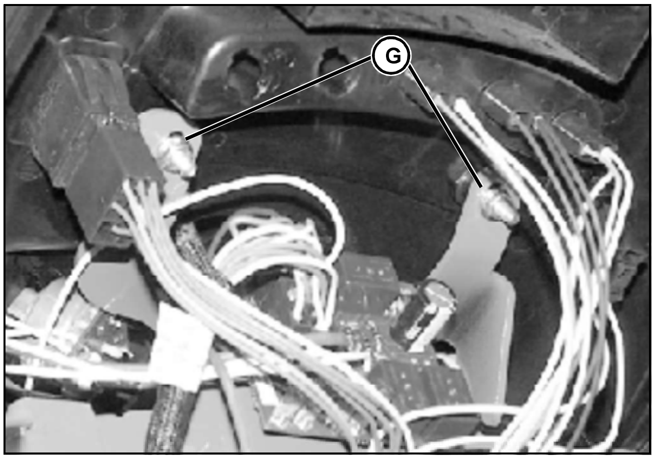


M95577

8. Remove parking brake handle (D) spring (E).

NOTE: The parking brake spring (E) is longer than the choke cable spring.

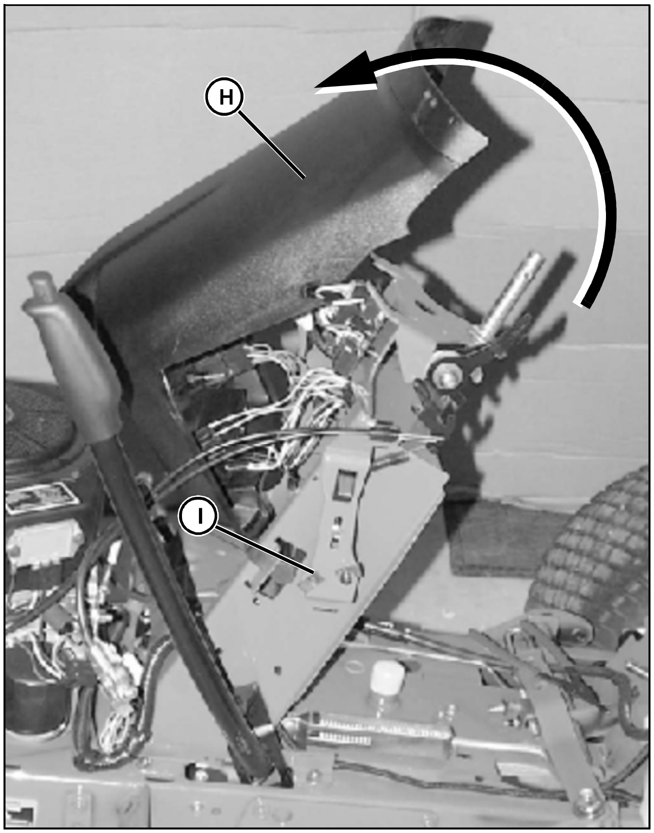
9. Gently pry sides of parking brake lever in and remove lever from pedestal cover. Remove parking brake handle from rod (F).



M95576

10.Remove two flange nuts (G) securing control panel to pedestal frame.

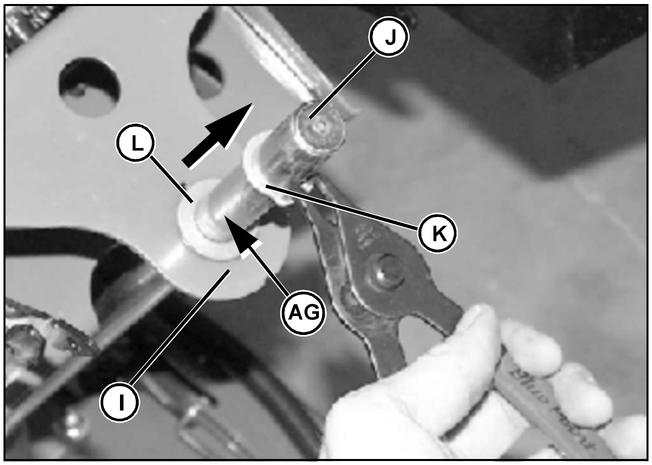
NOTE: It may be necessary to disconnect the wiring harness tie down clips before lifting pedestal cover.



M95578

11.Lift pedestal (I) cover (H) up and over the steering shaft (J), and rotate it forward over the pedestal frame to expose the entire steering shaft.

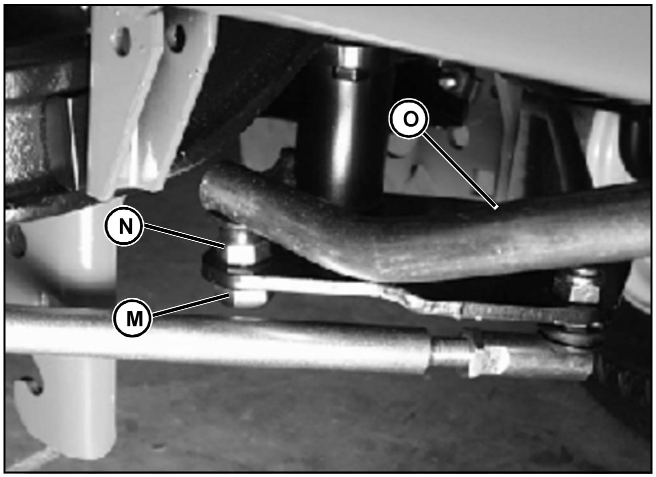
NOTE: Early style uses snap ring (K) shown to secure bushing. Late style uses cotter pin at location shown (AG).



M95583

12.Remove snap ring (K) holding bushing (L) in place in pedestal (I).

13.Remove bushing.



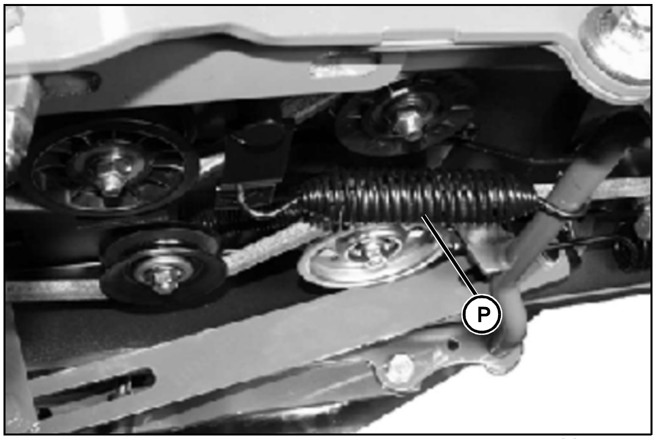
M95597

Picture Note: AWS Drag Link Shown

14.While holding the top nut (N) to prevent it from rotating, remove the lower nut (M) securing the front end of the drag link (O) to the front pivot plate.

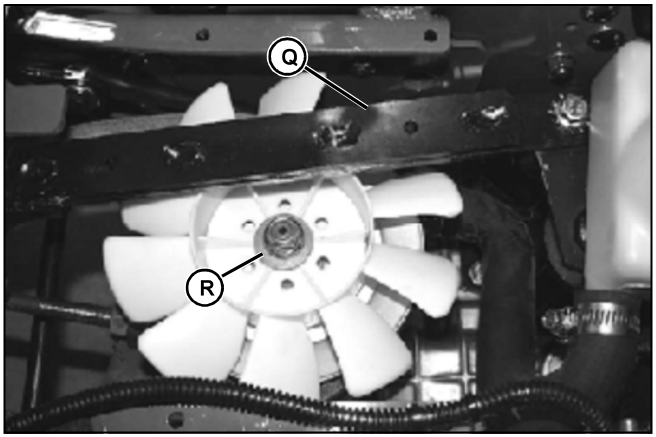
15.Remove drag link from steering cam.

CAUTION: Avoid Injury! The drive belt tension spring is under high tension when installed. Do disconnect spring without wearing face and hand protection.

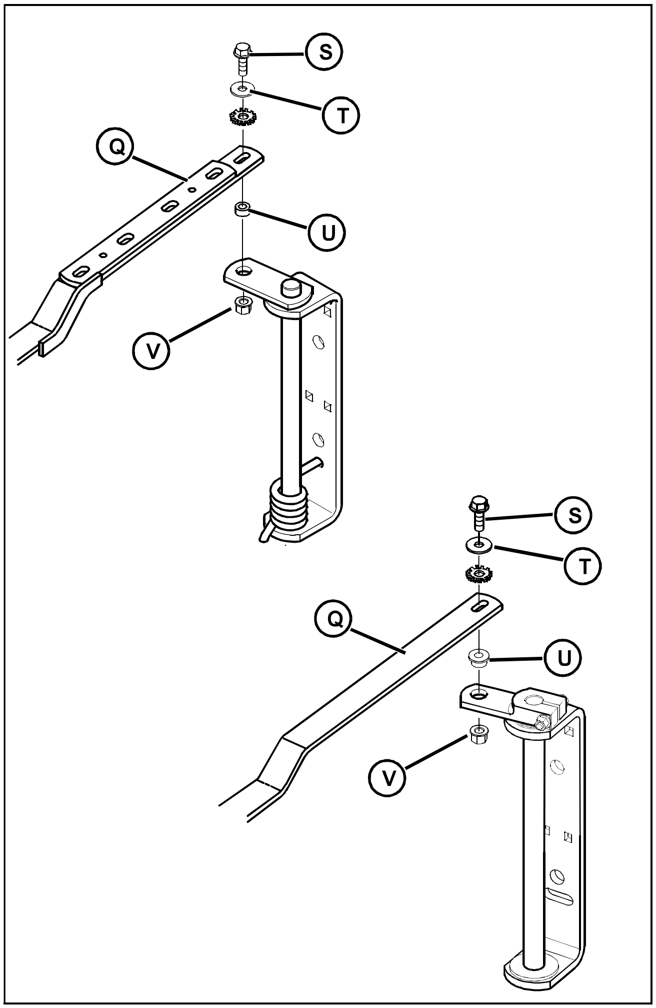


M99524

16.Disconnect drive belt tension spring (P) to remove tension from belt idler.



M95598



MIF

Picture Note: Top Graphic: LX277 (S/N -060000) Bottom Graphic: LX277 (S/N 060001-)

17.Pull transaxle fluid reservoir from back of fuel tank and set fuel tank out of the way to access transaxle fan.

18.AWS Only: Disconnect rear of control strap (Q) by removing bolt (S), washer (T) and star washer, bushing or bearing (U) and locknut (V) securing control strap to rear pivot.

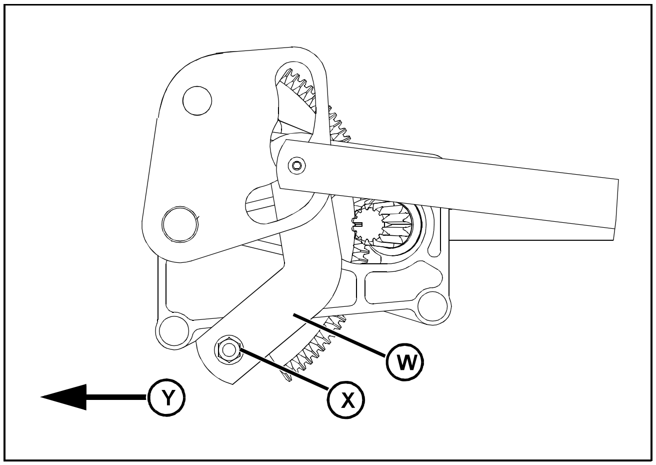
19.Remove nut and washer (R) securing transaxle fan. Remove fan.

20.Remove drive belt from transaxle.

NOTE: Removal of belt from transaxle allows access to bottom of steering cam for control arm removal.

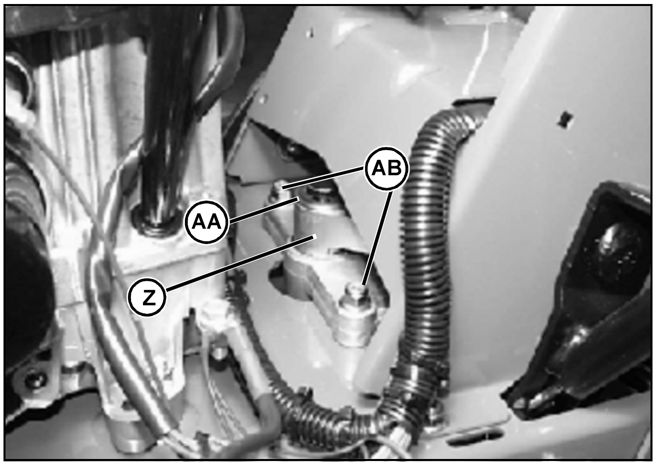
21.Go to either “Control Arm Removal (For AWS Machines Only - Except LX277):” on page 477 or “Control Arm Removal (For LX277 AWS Machine Only):” on page 477.

Control Arm Removal (For AWS Machines Only - Except LX277):

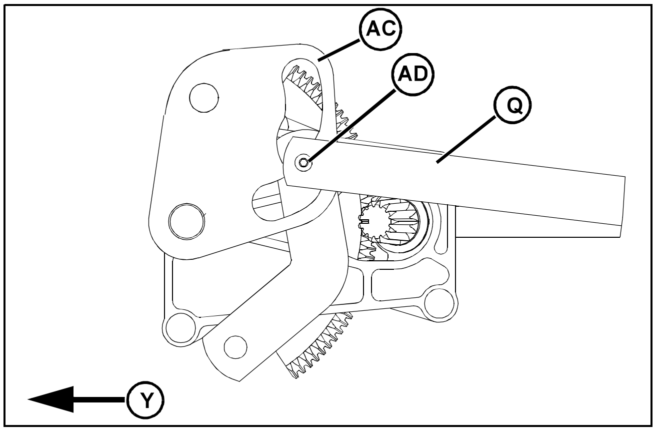


Picture Note: AWS - Shown From Bottom (front of machine (Y))

1. Remove the flange nut (X), bushing and cap screw securing control arm (W) to the frame.



2. Remove the E-clip, shim(s) (AA) and washer from the steering cam shaft. Lower steering cam through steering support and frame for removal of allen screw and locknut securing strap, cam and control arm together.



Picture Note: AWS - Shown From Bottom (front of machine (Y))

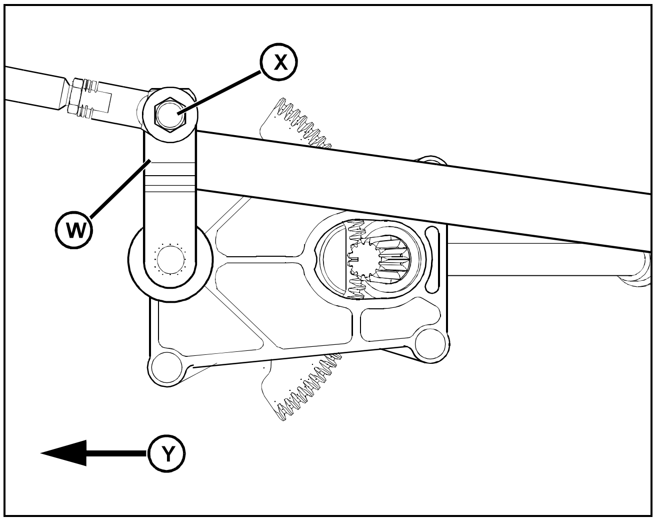
3. Remove the allen screw (AD), nut, washer and bearing securing the control strap (Q) to the steering cam (AC) and control arm.

4. Remove control arm, bearing, screw, washer and locknut.

5. Remove steering cam from machine.

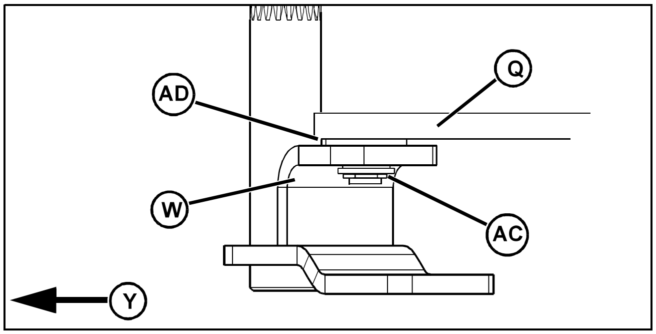
6. Go to “Control Arm Removal (For All AWS Machines):” on page 478.

Control Arm Removal (For LX277 AWS Machine Only):



Picture Note: LX277 AWS - Shown From Bottom (front of machine (Y))

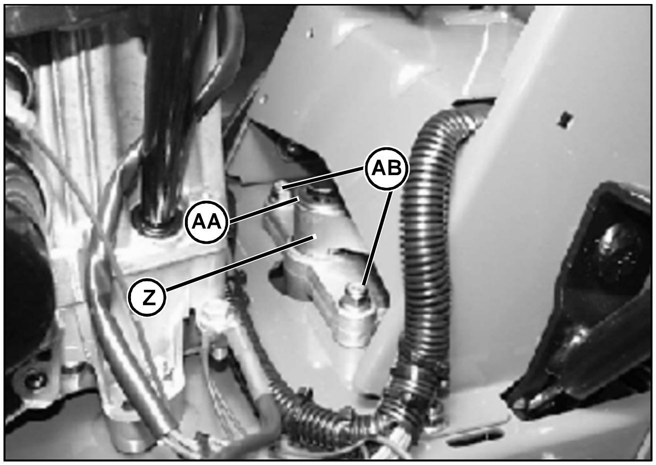
1. Remove the flange nut (X), spacer and carriage bolt securing tie rod to the sector arm (W).



Picture Note: LX277 AWS - Shown From Side

2. Remove the E-clip (AC) and washer, securing the control strap (Q) to the sector arm (W).

3. Remove and inspect bushing (AD).



4. Remove the E-clip, shims (AA) and washer from the sector arm shaft. Lower sector arm through sector gear (Z) and steering support.

5. Remove control arm, bearing, screw, washer and locknut.

6. Remove steering cam from machine.

7. Go to “Control Arm Removal (For All AWS Machines):” on page 478.

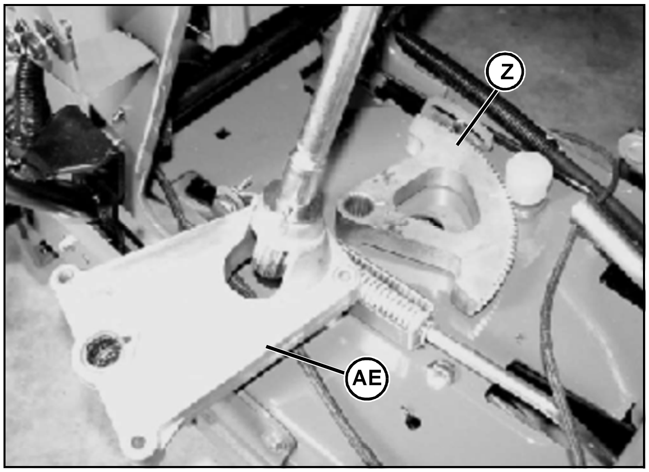
Control Arm Removal (For All AWS Machines):

1. Remove the four nuts and carriage bolts (AB) securing the steering support to the frame.

NOTE: Write down location and number of washers on pinion and sector gear shafts. If a new shaft is installed, number and placement of washers may need adjustment.

2. While raising the steering support, remove the sector gear (Z).

3. Remove center pivot from machine.



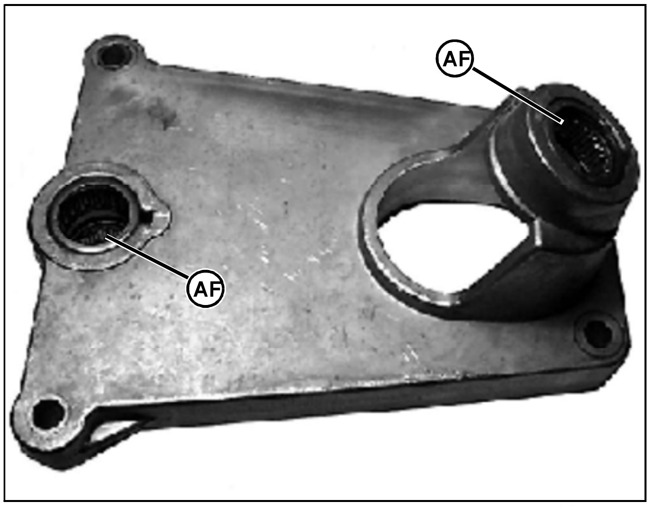
4. Rotate steering shaft and steering support (AE) and remove from machine.

5. Remove the cotter pin, washer, shim(s) and packing from the steering shaft.

6. Remove steering shaft from steering support.

7. Inspect shaft and steering gear assembly, replace as necessary.

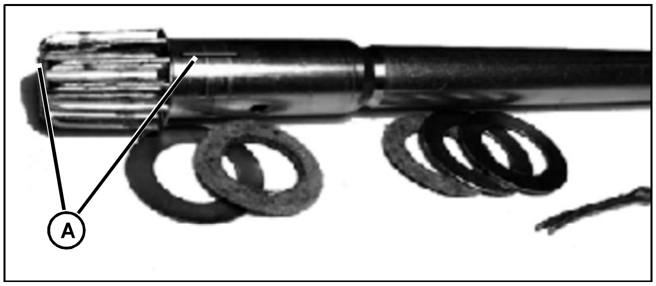
NOTE: Steering pinion gear cannot be removed from the steering shaft. There may be 0 - 3 washers installed above steering gear. These washers are not interchangeable with other washers on the shaft. They are needed to ensure proper pinion gear to sector gear (Z) engagement for proper steering response.



8. Inspect steering support needle bearings (AF) for damage. Replace as necessary.

NOTE: If any bearings are replaced, press bearings in until flush with surface. Ensure bearing side with lettering is toward outside.

Steering Gear Installation



M95602

1. Use a permanent marker to mark (A) the steering gear tooth that matches the alignment mark on the bottom of the steering shaft. The mark will be needed to align the sector gear during installation.

2. Install washer and packing onto steering shaft.

NOTE: During installation a felt packing will be installed between washers and any of the bearings in the steering support which hold either the steering shaft or the steering cam shaft.

3. Slide the steering shaft through the steering support.

4. Install second packing, spacer(s) and washer onto the steering shaft. Install cotter pin through hole in steering shaft.

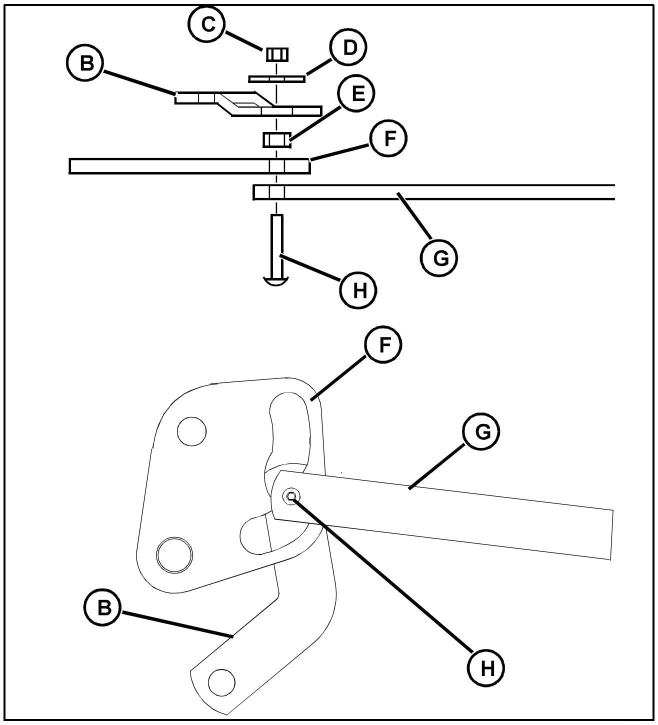
NOTE: Spacer(s) above steering support are installed to eliminate rattle. Before bending cotter pin over, check for movement of steering shaft through steering support. Remove cotter pin and washer, and add spacers as needed to eliminate movement. Reinstall washer and cotter pin.

5. Bend ends of cotter pin over.

6. Slide steering shaft through pedestal and place into approximate installed position.

7. Set sector gear on top of steering support.

Control Arm Installation (For AWS Machines Only - Except LX277):

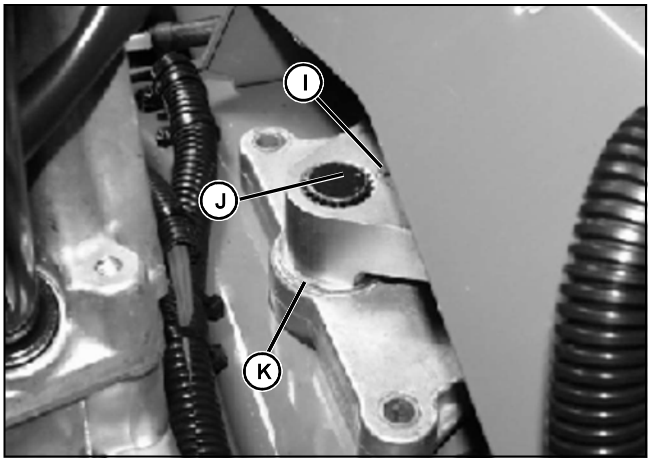


MIF

Picture Note: Side View (Top)
Bottom View (Bottom) of graphic

1. Install allen head screw (H) though control strap (G), steering cam (F), roller (E), control arm (B), washer (D) and locknut (C). Tighten locknut and screw to 16 N•m (142 lb-in.).

2. Install a washer and packing on the steering cam splined shaft.

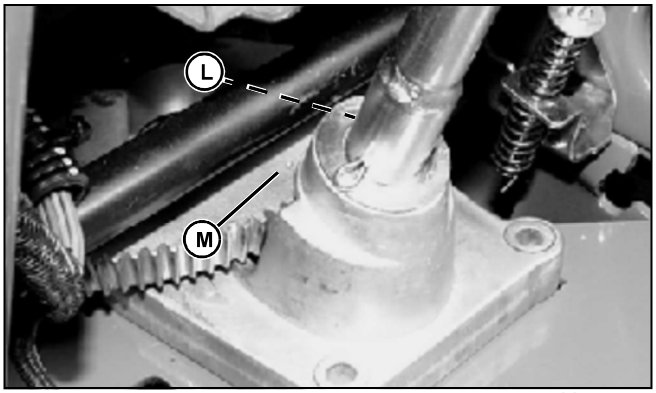


M95635

3. Slide the splined steering cam shaft up through the steering support. Install the second washer and packing (K) on the steering cam splined shaft and then slide splined shaft through sector gear.

4. Ensure steering cam shaft alignment mark (J) and sector gear alignment mark (I) are matched. Install shim(s),

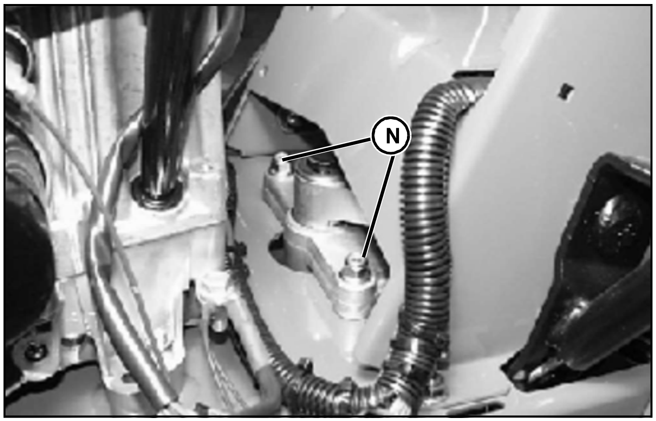
washer and E-clip on steering cam shaft.



M95634

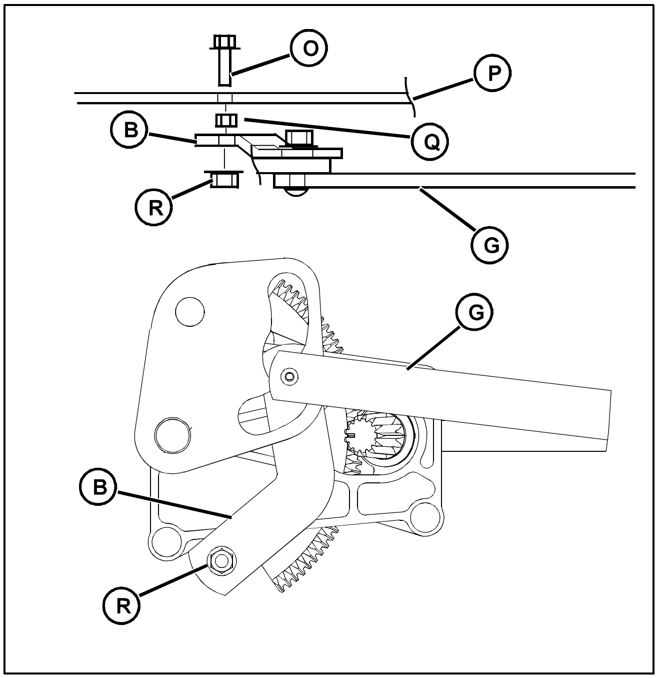
5. Ensure steering gear alignment mark (L) and sector gear alignment mark (M) are aligned.

NOTE: The steering shaft alignment mark is 90° from cotter pin hole.



M96601

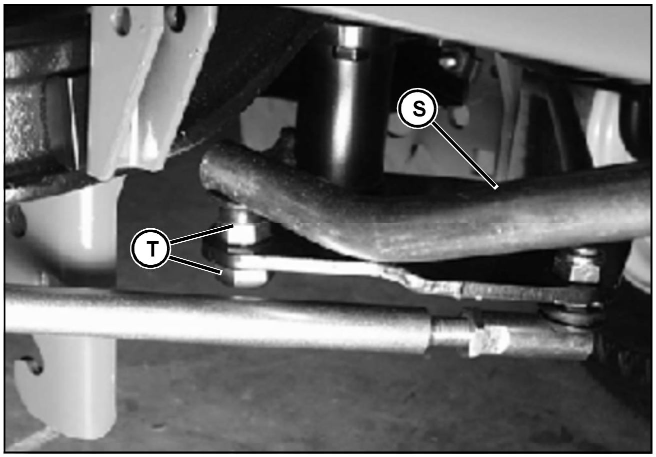
6. Secure steering support to frame with four carriage bolts and locknuts (N). Tighten locknuts to 22 N•m (192 lb-in.).



MIF

Picture Note: Side View (Top)
Bottom View (AWS - Bottom) of graphic

7. Install carriage bolt (O) through frame (P), bushing (Q) and control arm (B). Tighten locknut (R) and bolt securing control arm to frame to 32 N•m (23 lb-ft).



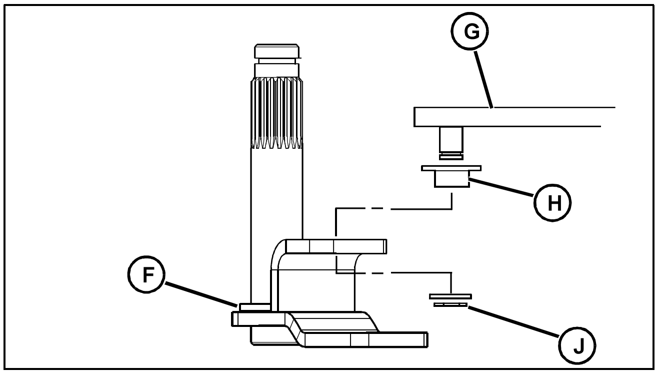
M95597

Picture Note: AWS Drag Link Shown

8. Install drag link (S) to front pivot and steering cam. Tighten drag link locking nuts (T) to 60 N•m (44 lb-ft).

9. See “Steering Shaft Installation (For All AWS Machines):” on page 482.

Control Arm Installation (For LX277 AWS Machine Only):



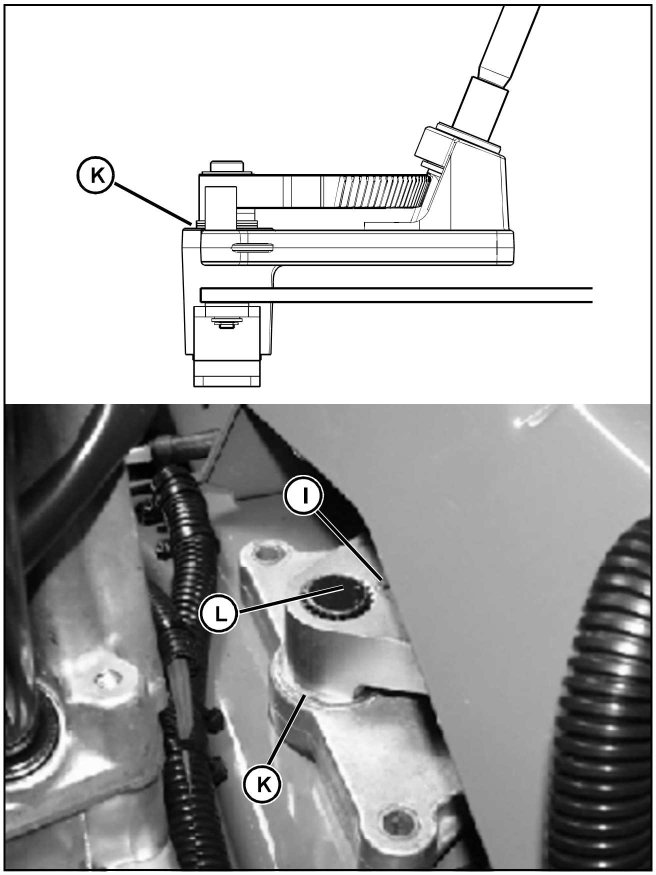
MIF

Picture Note: Side View

1. Install a washer (F) on the steering arm splined shaft.

2. Install control strap (G) through bushing (H) and sector arm. Install washer to strap and secure control strap to sector arm with E-clip (J).

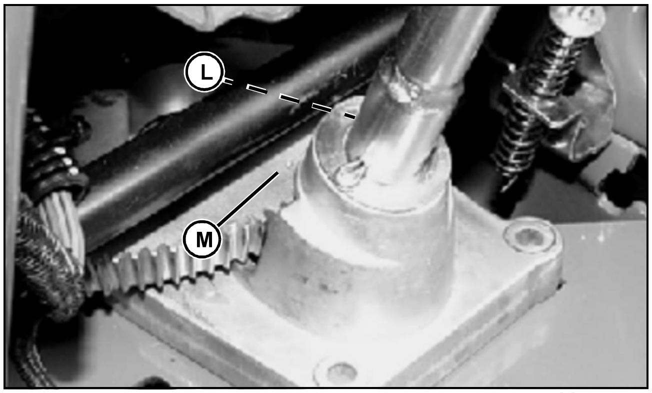
NOTE: Ensure that the E-Clip (J) is seated properly.



MIF, M95635

3. Slide the splined steering arm shaft up through the steering support. Install the second washer and packing (K) on the steering arm splined shaft and then slide splined shaft through sector gear.

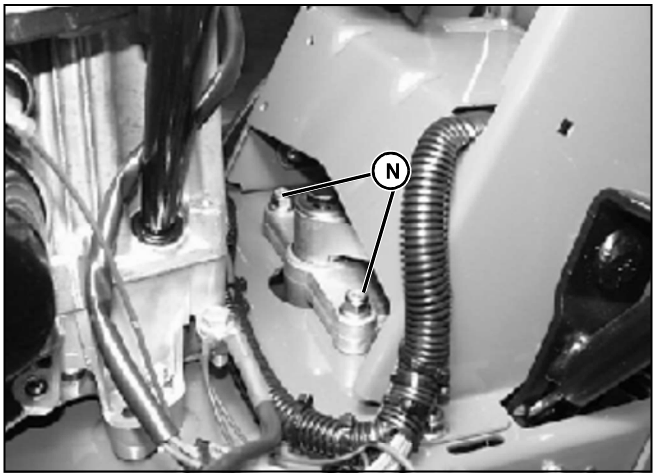
4. Ensure steering cam shaft alignment mark (L) and sector gear alignment mark (I) are matched. Install washer and E-clip on steering arm shaft.



M95634

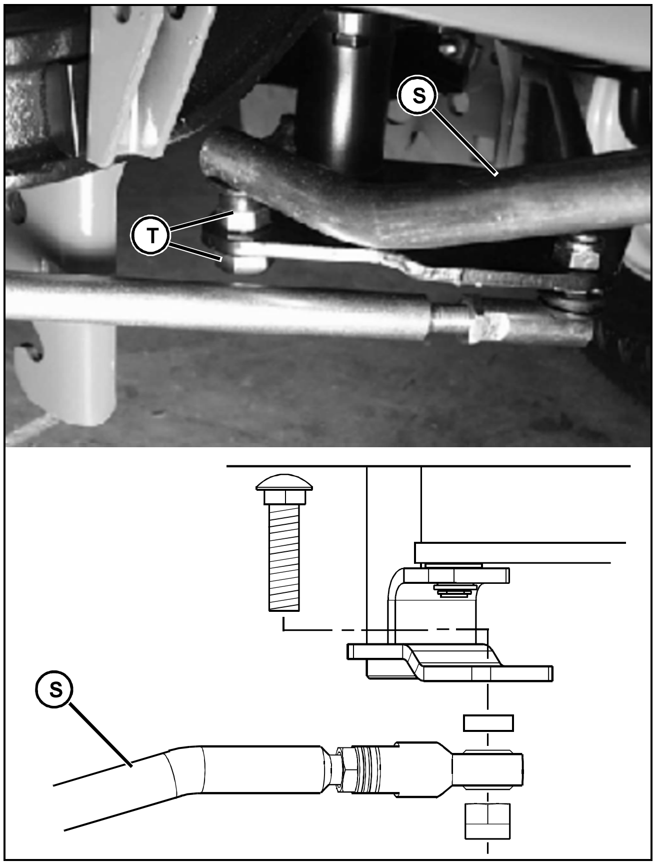
5. Ensure steering gear alignment mark (L) and sector gear alignment mark (M) are aligned.

NOTE: The steering shaft alignment mark is 90° from steering wheel bolt hole (near top of shaft).



M96601

6. Secure steering support to frame with four carriage bolts and locknuts (N). Tighten locknuts to 22 N•m (192 lb-in.).



M95597, MIF

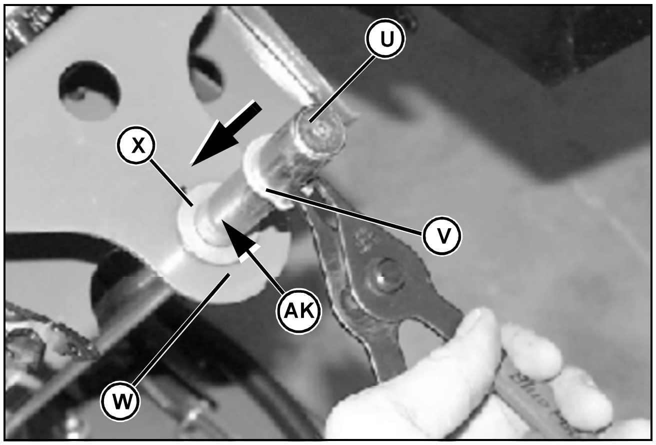
Picture Note: AWD Drag Link Shown

7. Install drag link (S) to front pivot and steering arm. Tighten drag link front locking nuts (T) to 60 N•m (44 lb-ft).

8. Install carriage bolt through sector arm. Install spacer, drag link and locknut to carriage bolt. Tighten nut to 55 N•m (41 lb-ft).

Steering Shaft Installation (For All AWS Machines):

NOTE: Early style uses snap ring (V) shown to secure bushing. Late style uses cotter pin at location shown (AK).

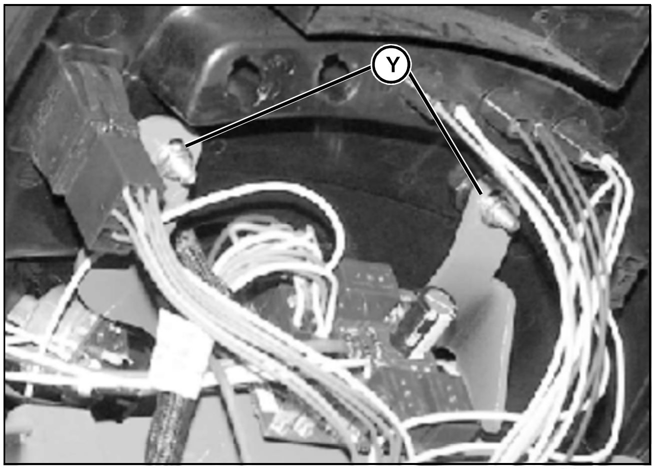


M95583

1. Install steering column bushing (X).

2. Install snap ring (V) holding bushing (X) in place in pedestal (W).

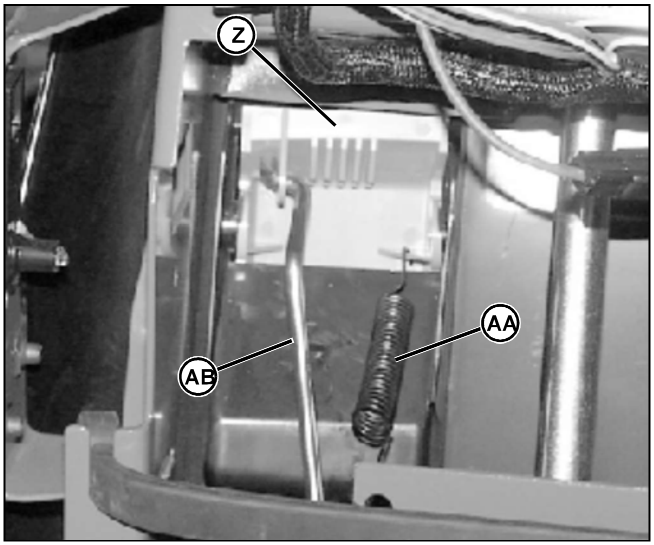
3. Lift pedestal cover up and over the steering shaft (U). Ensure pedestal cover slides under two side screws and washers. Tighten screws.



M95576

4. Install two flange nuts (Y) securing control panel to pedestal frame.

5. Ensure all electrical connectors are secure.



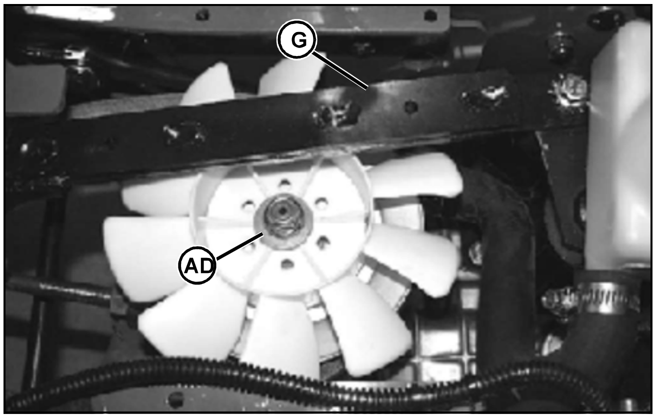
M95577

6. Connect parking brake handle (Z) to rod (AB).
7. Install parking brake lever in pedestal cover.
8. Connect parking brake lever spring (AA).

M96429

9. Install steering wheel and secure with locknut (AC) and bolt. Snug locknut. Do not tighten locknut to pull washer or head of bolt into steering wheel.

10. Install throttle and choke knobs. Install choke return spring.

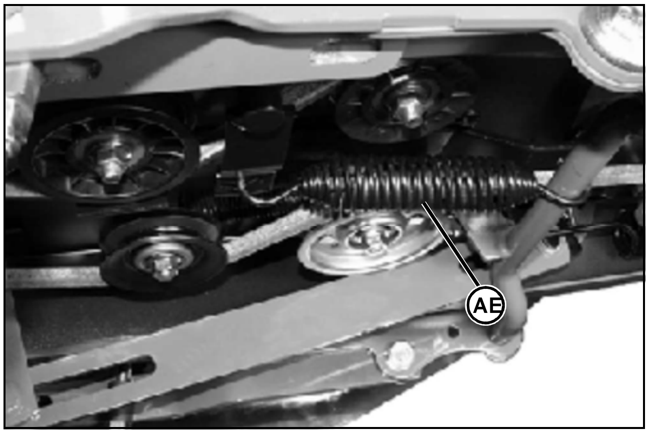


M95598

11. Ensure proper routing of transmission belt and install belt on transmission.

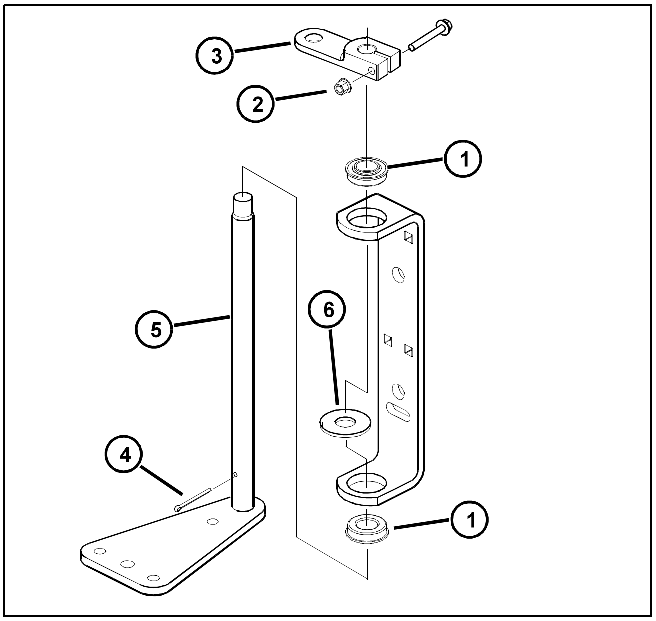
12. Install transmission fan, washer and locknut (AD). Tighten locknut to 30 N•m (22 lb-ft).

CAUTION: Avoid injury! The drive belt tension spring is under high tension when installed. Do install spring without wearing face and hand protection.



M99524

13. Connect drive belt tension spring (AE).



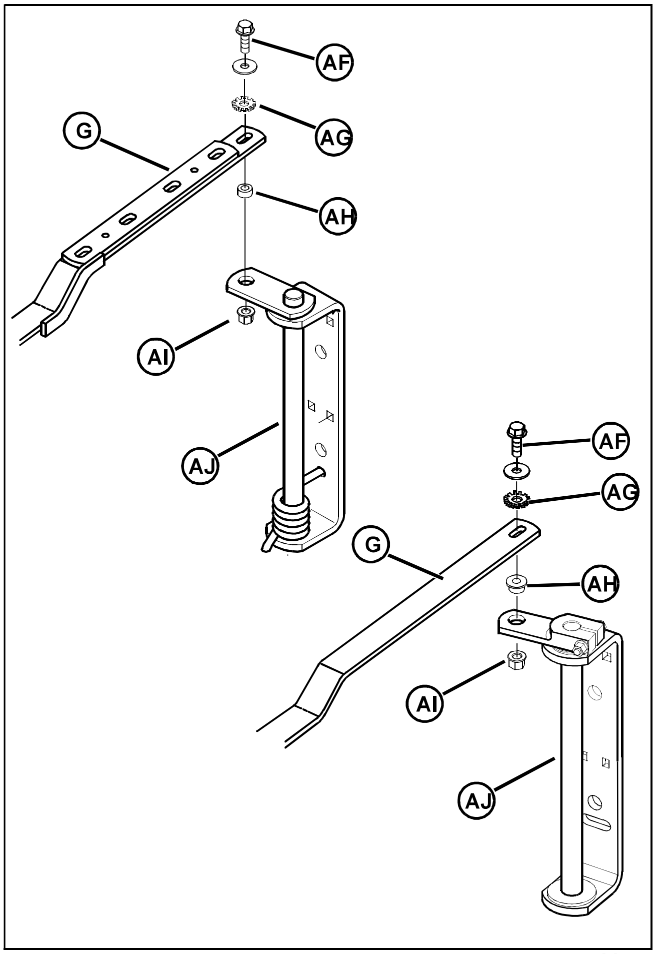
MIF

14.For LX277 Only: Before securing control strap (G) check rear pivot and bearings (1) for ease of movement and excess play. If necessary, replace bearings by:

- Removing nut (2) and bolt.
- Removing arm (3).
- Removing cotter pin (4).
- Removing pivot (5) and rubber seal (6).

Installation is reverse order of removal.

- Rubber seal must contact lower bearing.
- Tighten nut (2) to 15 N•m (133 lb-in.).



MIF

Picture Note: Top Graphic: LX277 (S/N -060000) Bottom Graphic: LX277 (S/N 060001-)

15.Install control strap (G) to rear pivot (AJ), and secure with bolt (AF), washer and star washer (AG), bearing (AH) and flange nut (AI).

16.Tighten flange nut to 31 N•m (23 lb-ft).

17.Align all wheels. See “Toe-In Adjustment - AWS Rear” on page 472.

18.Tighten nut to 30 N•m (22 lb-ft).

19.Install fuel tank and transmission fluid reservoir. Ensure fuel line and seat switch wiring are routed in molded grove in fuel tank.

20.Install fender deck. See “Fender Deck Removal and Installation” on page 590 in the Miscellaneous section.

21.Install battery.

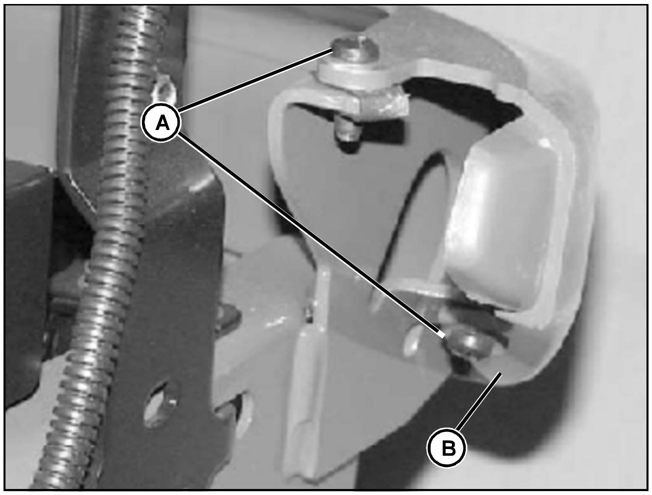
22.Install pedestal left and right closeout panels.

23.Install mower deck.

Front Axle Removal, Disassembly, and Inspection

Removal:

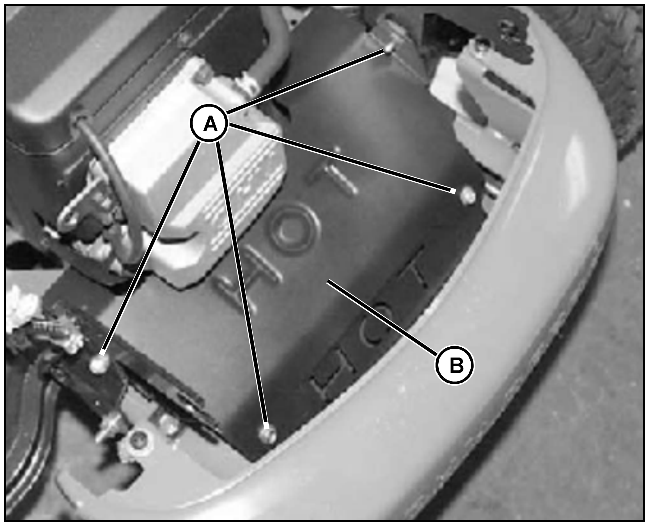
1. Remove mower deck. See Mower Deck Removal and Installation for the appropriate deck in Attachments section.
2. Remove hood. See “Hood Removal and Installation” on page 589 in the Miscellaneous section.
3. Raise front of machine, and support by the frame using suitable stands.



M95518

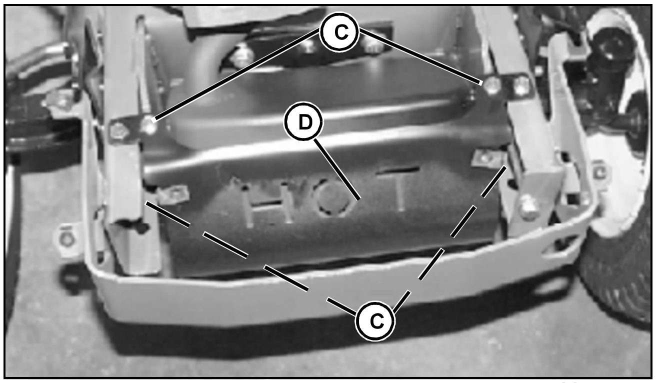
4. Remove four screws (A) securing bumper cover (B) to frame.

Kohler Engine:

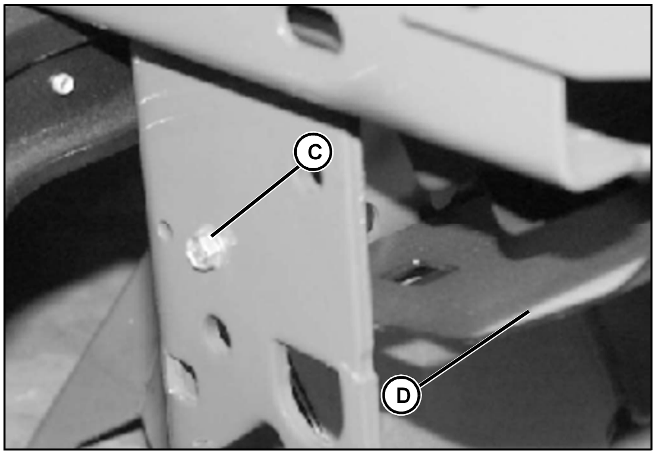


M95517

1. Remove four cap screws (A) and upper heat shield (B).

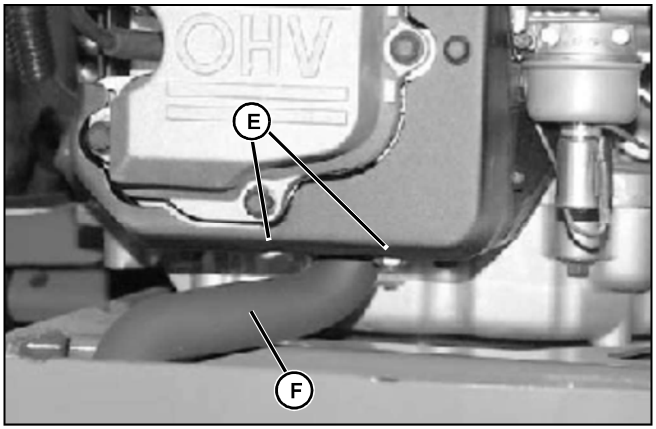


M95523



M95524

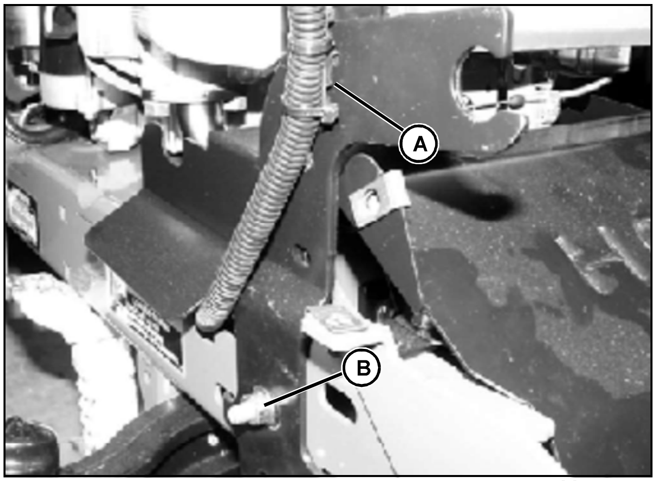
2. Remove four cap screws (C) and lower heat shield (D).



M95525

3. Remove two lock washers and nuts (E) securing the muffler exhaust tube (F) to the cylinder head.
4. Loosen four engine mounting bolts, and raise front of engine slightly.
5. Remove muffler and muffler gasket.

Kawasaki and B&S Engines:

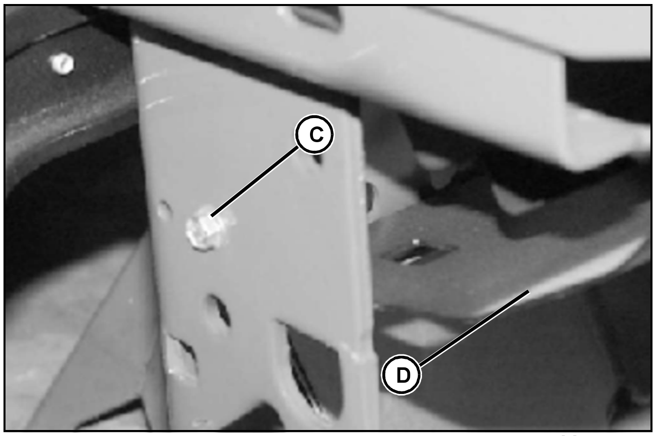


M99525

1. Remove headlight wiring harness clip (A) from frame.

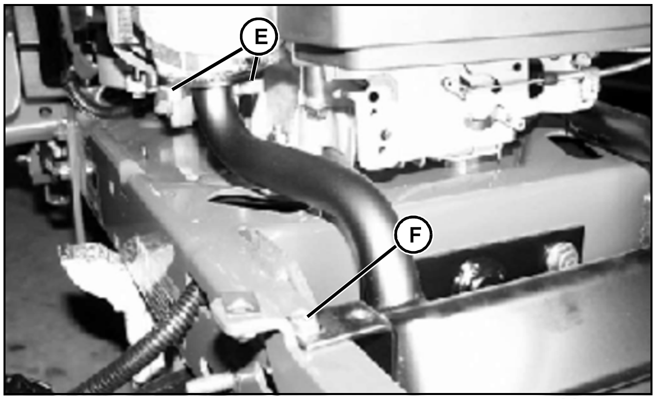
2. Loosen (or remove) two flange nuts (B) securing hood support brackets. Move brackets out to allow removal of upper heat shield.

3. Remove four cap screws and upper heat shield.



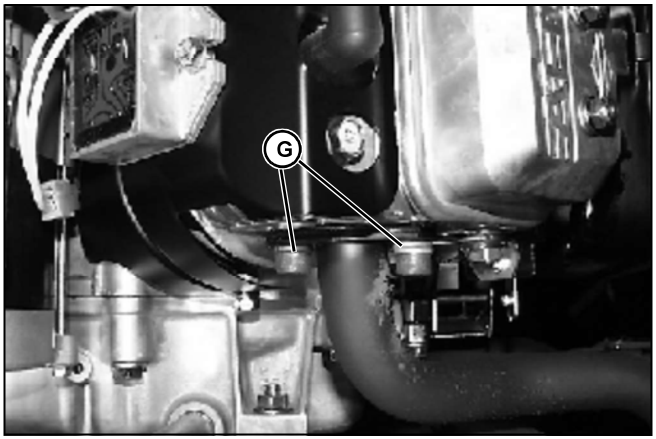
M95524

4. Remove four cap screws (C) and lower heat shield (D).



M99526

Picture Note: Kawasaki Engine Shown



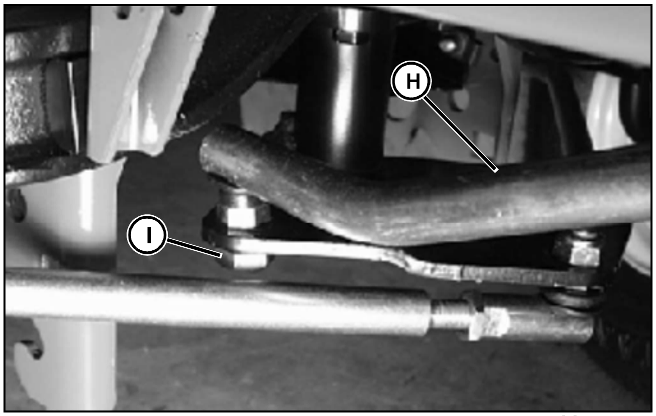
M99593

Picture Note: Briggs and Stratton Engine Shown

5. Kawasaki - Remove two cap screws (F) securing muffler to frame. Remove four nuts and lock washers (E) securing muffler to engine. Remove muffler.

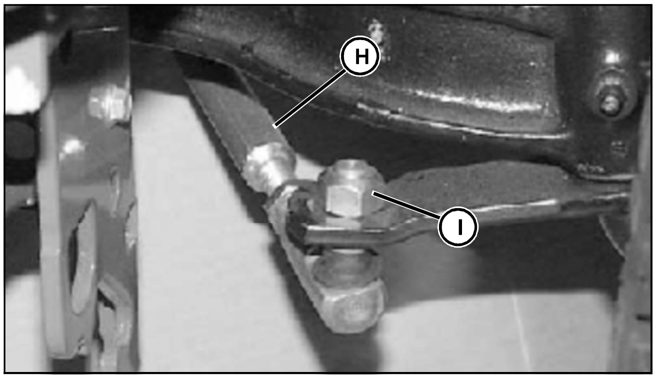
6. B&S - Remove two cap screws securing muffler to frame. Remove four allen head bolts (G) and lock washers securing muffler to engine. Remove muffler.

All Machines:



M95597

Picture Note: AWS Drag Link Shown



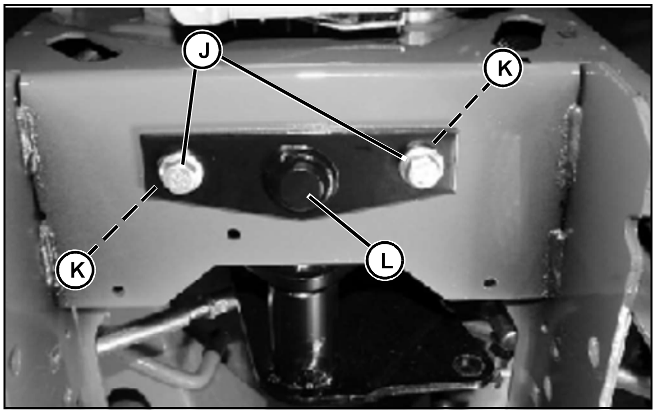
M95522

Picture Note: 2WS Drag Link Shown

STEERING REPAIR

1. Remove locknut (I) securing drag link (H) to left front wheel steering arm. Move drag link out of the way.

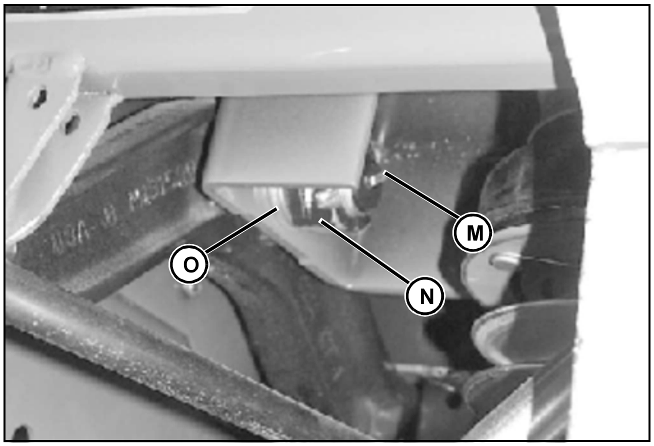
IMPORTANT: Avoid damage! Front axle is secured to frame with one pivot pin. Use care when removing pivot pin to prevent beam axle from falling to floor.



M99527

Picture Note: AWS Shown

2. Remove two cap screws (J) and locknuts (K) securing pivot pin (L) and front axle to frame.



M95538

3. Underneath machine, remove cotter pin (M), nut (N), and washer(s) (O) from end of pivot pin.

4. Support front axle and remove pivot pin. Remove front axle from frame.

Disassembly and Inspection:

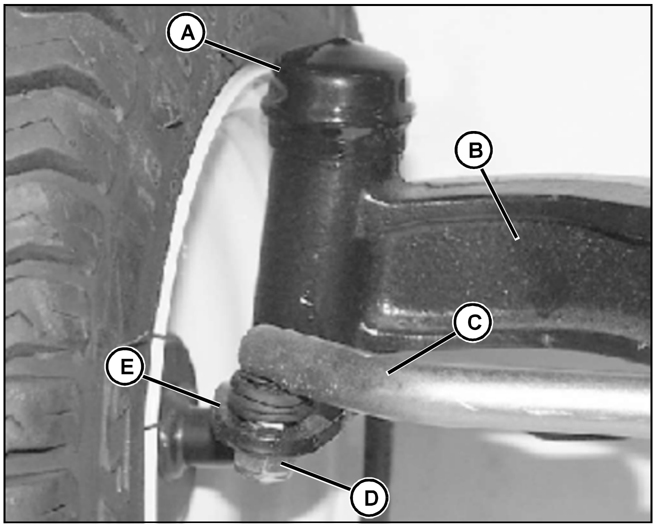
1. Measure axle beam pivot OD.

2. Measure ID of axle beam pivot bushings.

3. Subtract the ID from the OD. If clearance measurement difference is not within 0.05 mm (0.002 in.) (maximum), replace bushings.

4. If necessary, remove wheels from spindles. See “Front Wheel Removal and Installation” on page 492.

2WS Machines:

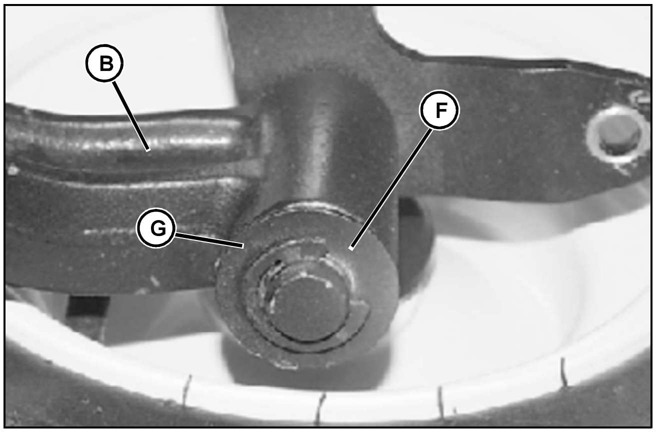


M95537

1. Remove two locknuts (D) securing tie rod ends to spindle steering arms (E). Remove tie rod (C).

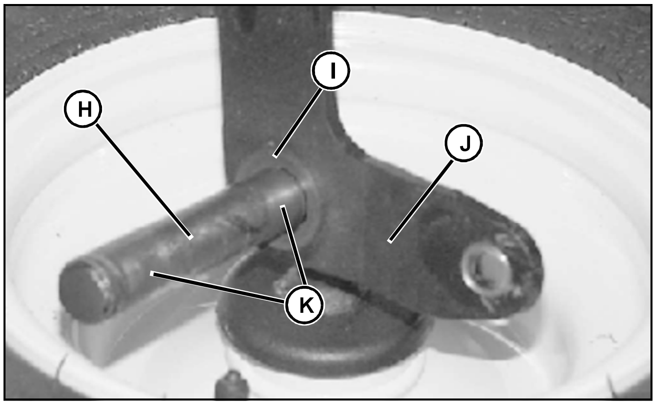
2. Inspect tie rod ball joints for smooth operation. Be sure boot is in place. If needed, replace tie rod.

3. Remove plastic cap (A) from top of spindle.



M95539

4. Remove E-ring (G) and washer (F) from end of spindle. Remove spindle from axle beam (B).



M95540

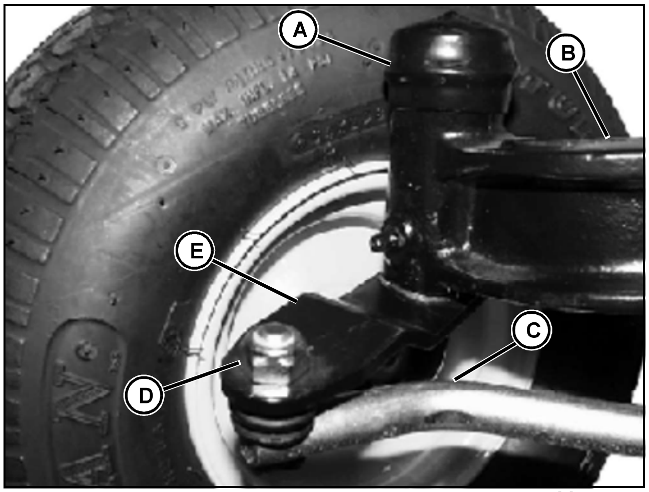
5. Inspect thrust surface (I) and rotation wear surface (K) on spindle (H) and steering arm (J). If excessively worn or grooved, replace spindle assembly.

6. Measure ID of spindle bushings.

7. Measure the OD of the spindles.

8. Subtract the ID from the OD. If clearance measurement difference is not within 0.05 mm (0.002 in.) (maximum), replace bushings.

AWS Machines:

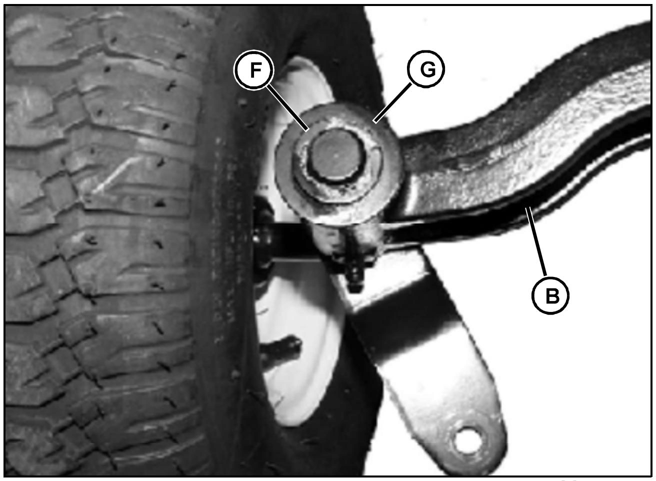


Picture Note: AWS Shown

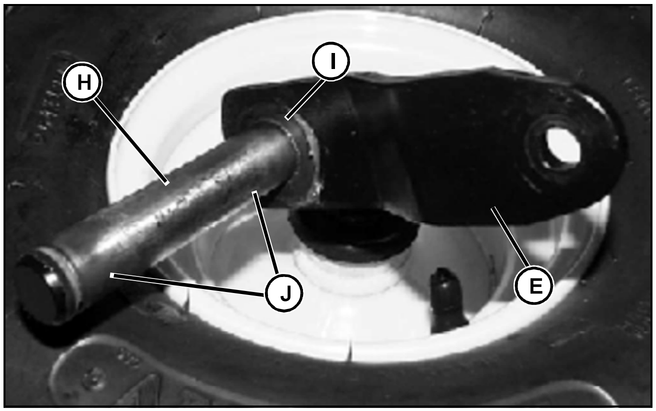
1. While holding ball joint to keep it from turning, remove locknut (D) securing tie rod end to spindle steering arms (E). Remove tie rod (C).

2. Inspect tie rod ball joint for smooth operation. Be sure boot is in place. If needed, replace tie rod.

3. Remove plastic cap (A) from top of spindle.



4. Remove E-ring (F) and washer (G) from end of spindle. Remove spindle from axle beam (B).



5. Inspect thrust surface (I) and rotation wear surface (J) on spindle (H) and steering arm (E). If excessively worn or grooved, replace spindle assembly.

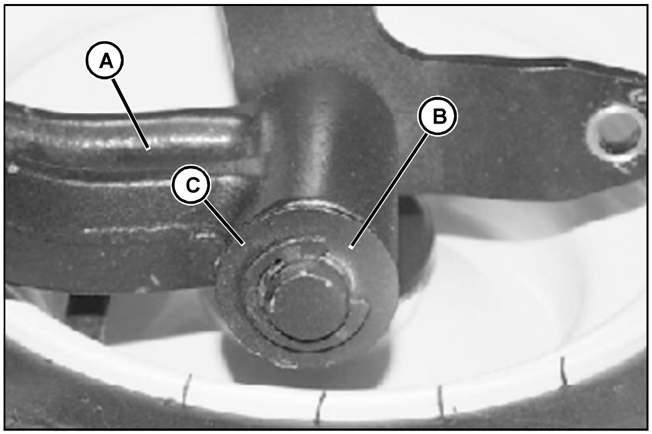
6. Measure ID of spindle bushings.

7. Measure the OD of the spindles.

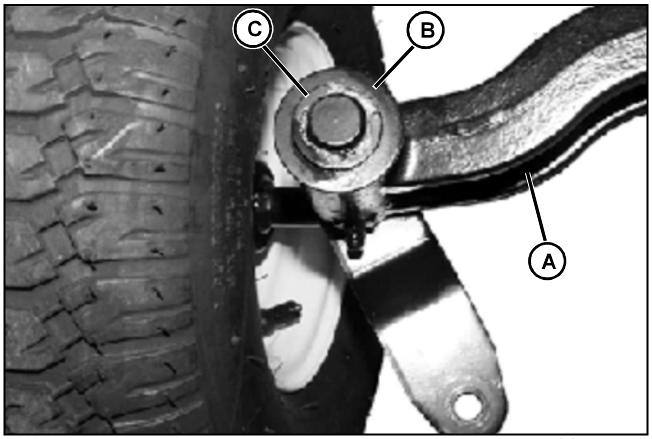
8. Subtract the ID from the OD. If clearance measurement difference is not within 0.05 mm (0.002 in.) (maximum), replace bushings.

Front Axle Assembly and Installation

NOTE: Be sure bushings in axle beam (A) are in good condition before assembling front axle.

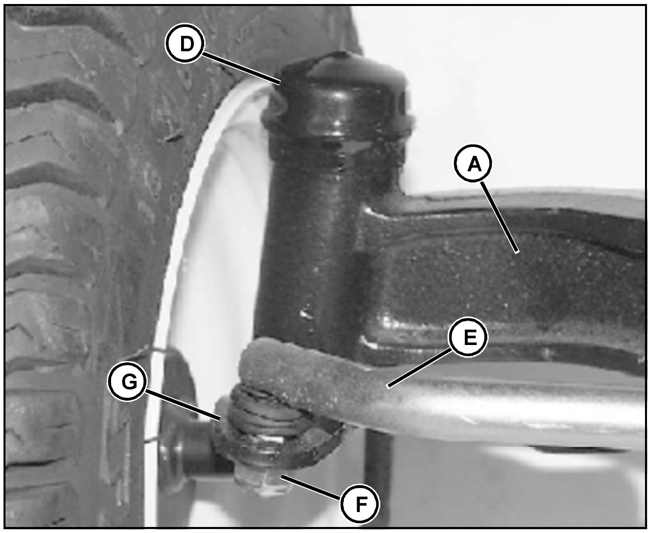


Picture Note: 2WS Shown

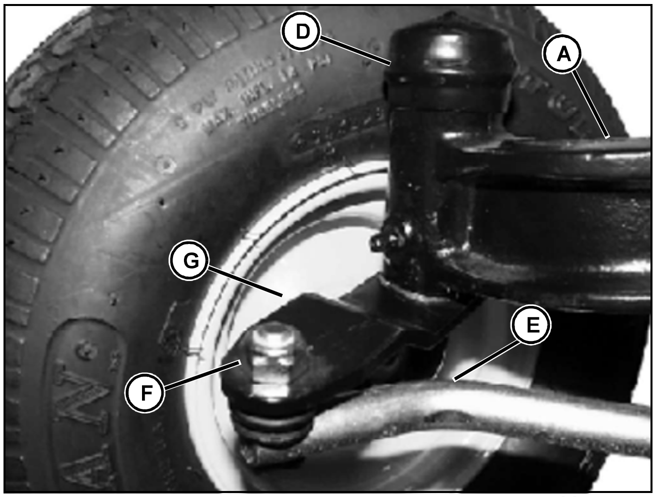


Picture Note: AWS Shown

1. Install spindles to front axle beam (A). Retain with washer (B) and E-ring (C).


D
A
E
G
F
M95537

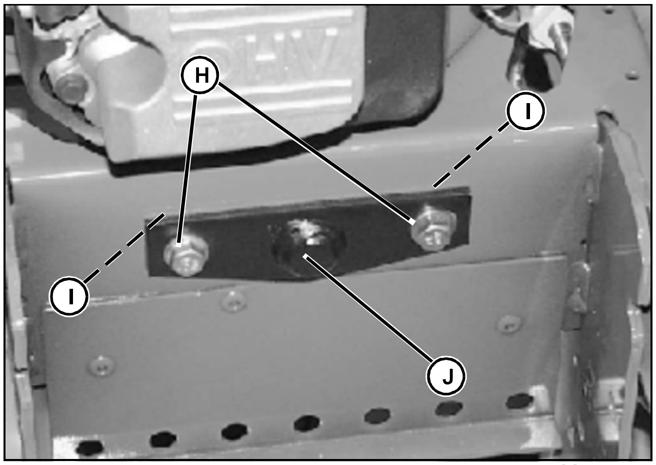
Picture Note: 2WS Shown


D
A
G
E
F
M95537

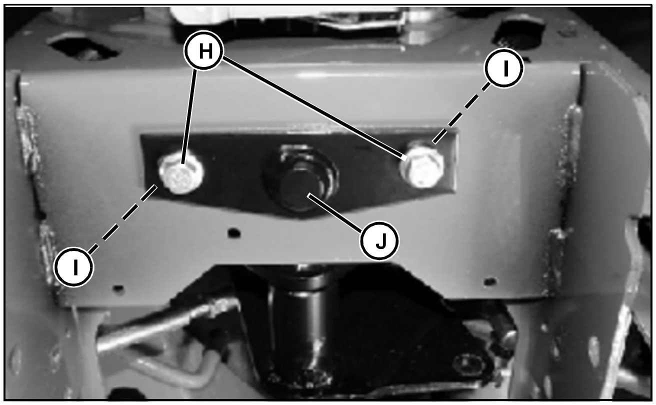
Picture Note: AWS Shown

2. Install plastic cap (D) to top of spindle.

3. Install tie rod (E) onto spindle steering arm (G). Retain with two locknuts (F). Tighten locknuts to 60 N•m (44 lb-ft).


H
I
I
J
M95536

Picture Note: 2WS Shown

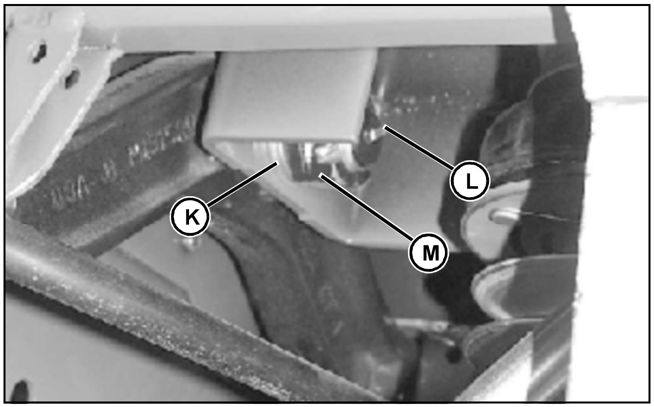

H
I
I
J
M99527

Picture Note: AWS Shown

4. Apply grease to inside of axle pivot .

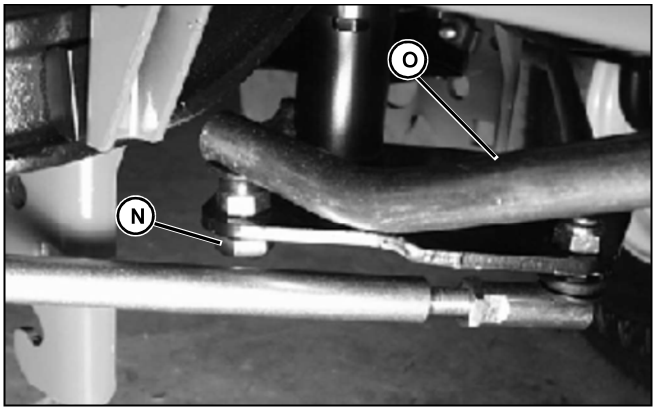
5. Install front axle to machine. Retain with pivot pin (J).

6. Install two cap screws (H) and locknuts (I) to secure pivot pin and front axle to frame. Tighten cap screws and locknuts to 65 N•m (48 lb-ft).



7. Install washer(s) (K) and nut (M) to pivot pin.

8. Install cotter pin (L) to retain nut to pivot pin.



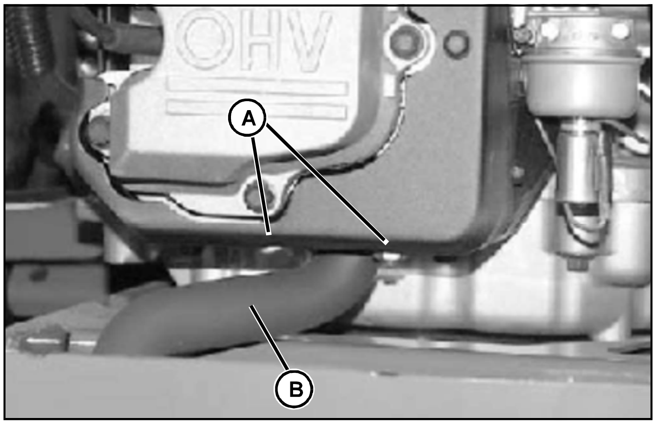
M95597

Picture Note: AWS Drag Link Shown

9. Attach drag link (O) to spindle steering arm. Retain with locknut (N). Tighten locknut to 60 N•m (44 lb-ft).

Kohler Engine:

IMPORTANT: Avoid damage! Be sure muffler gasket is in place on exhaust tube (B) flange when installing muffler to cylinder head. DO NOT overtighten screws securing muffler, and muffler heat shields.

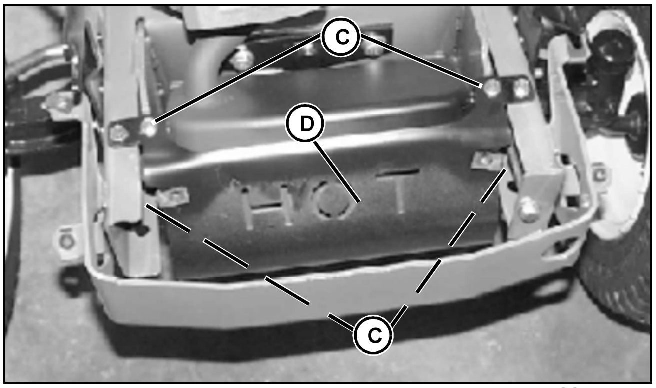


M95525

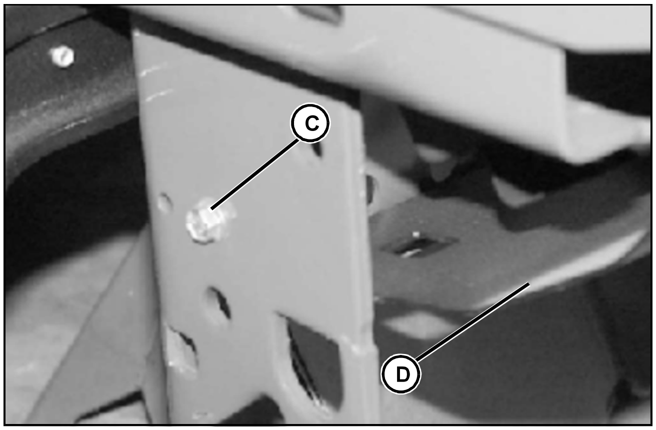
1. Raise front of engine slightly, and install muffler to cylinder head. Retain with two lock washers and nuts (A). Tighten nuts to 20 - 25 N•m (168 - 204 lb-in.).

2. Install two cap screws retaining muffler to frame.

3. Tighten four engine mounting bolts to 29 - 35 N•m (22 - 26 lb-ft).

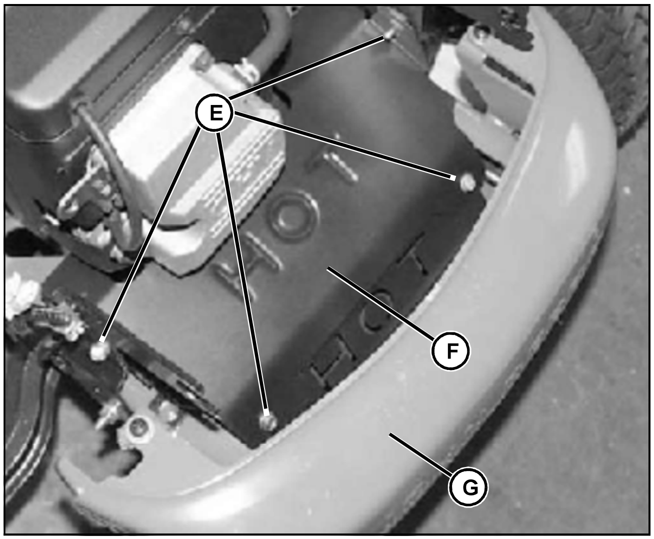


M95523



M95524

4. Install lower heat shield (D). Retain with four cap screws (C).



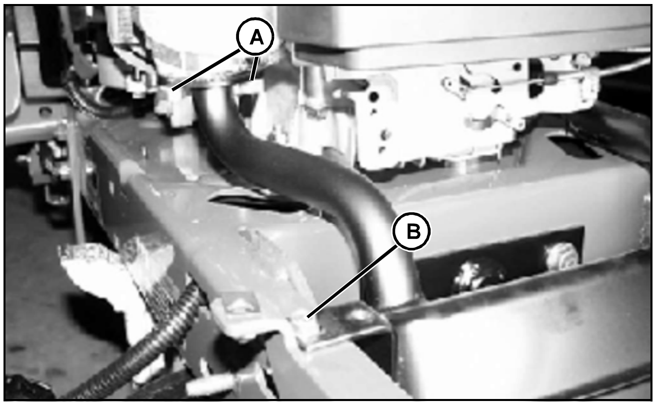
M95517

5. Install upper heat shield (F), retain with four cap screws (E).

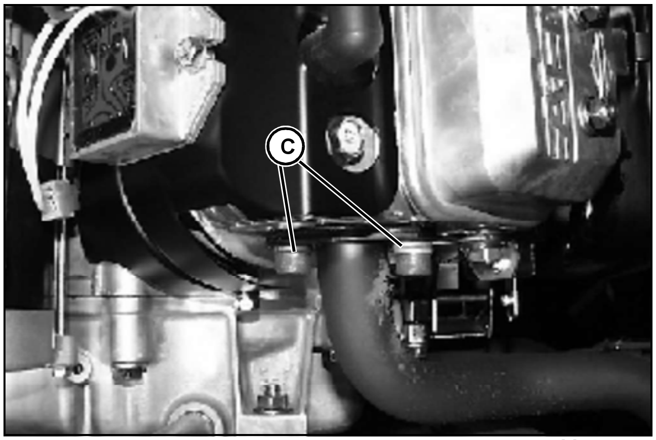
6. Install bumper cover (G).

Kawasaki and B&S Engines:

IMPORTANT: Avoid damage! Be sure muffler gaskets are in place on exhaust tube flanges when installing muffler to cylinder heads. DO NOT overtighten nuts securing muffler.



Picture Note: Kawasaki Engine Shown



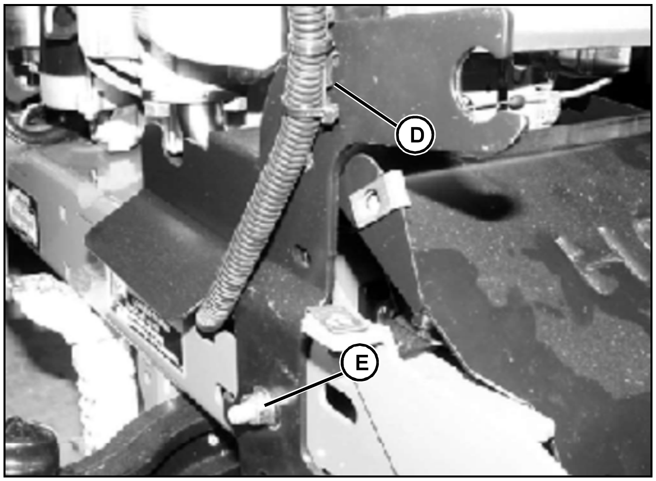
Picture Note: Briggs & Stratton Engine Shown

1. Kawasaki - Install muffler gaskets to muffler. Install muffler to frame and secure with two cap screws (B). Install four lock washers and nuts (A) to secure muffler to engine. Tighten nuts to 6.9 N•m (61 lb-in.).

2. B&S - Install muffler gaskets to muffler. Install muffler to engine and secure with four allen head bolts (C) and lock washers. Tighten allen head bolts to 17 N•m (150 lb-in.). Install two cap screws to secure muffler to frame.

3. Install lower heat shield and secure with four cap screws.

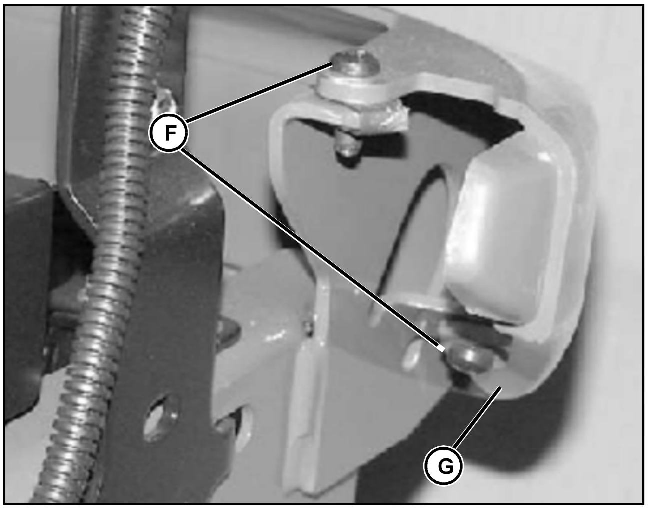
4. Install upper heat shield and secure with four cap screws.



5. Install (if removed) hood brackets and secure with two flange nuts (E). Tighten flange nuts.

6. Connect headlight wiring harness clip (D) to frame.

All Machines:



1. Install bumper cover (G) to frame. Retain with four screws (F).

2. Raise front of machine, remove stands, and lower machine to the ground.

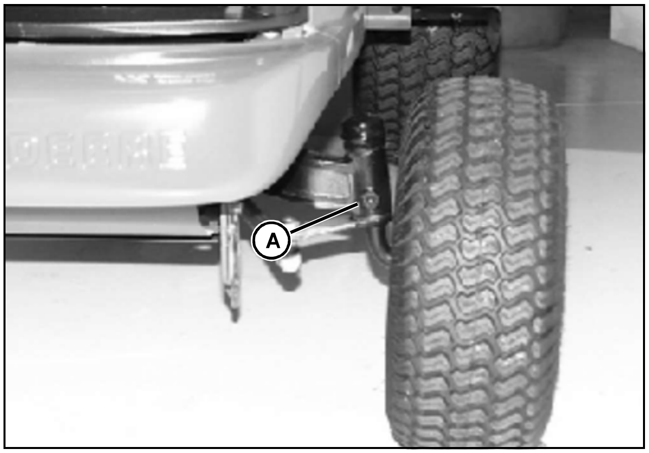
3. Install hood. See “Hood Removal and Installation” on page 589 in the Miscellaneous section.

4. Install mower deck. See Mower Deck Removal and Installation for the appropriate deck in Attachments section.

5. Lubricate spindles using John Deere Extreme Pressure Grease or an equivalent.

Front Wheel Spindle Lubrication

1. Raise each wheel off of ground so grease can get around spindle.



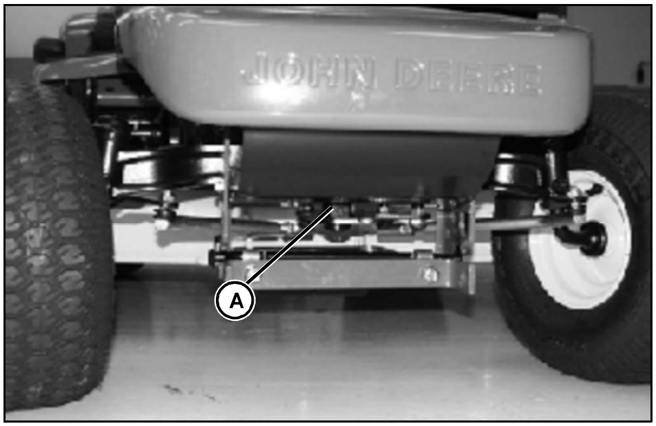
M96432

2. Lubricate front wheel spindle through lubrication fitting (A), on each side of machine, with one or two shots of John Deere Extreme Pressure Grease or an equivalent until grease comes out of spindle. Wipe off excess.

3. Turn steering wheel back and forth several times to distribute grease on spindles.

Front Axle Pivot Lubrication

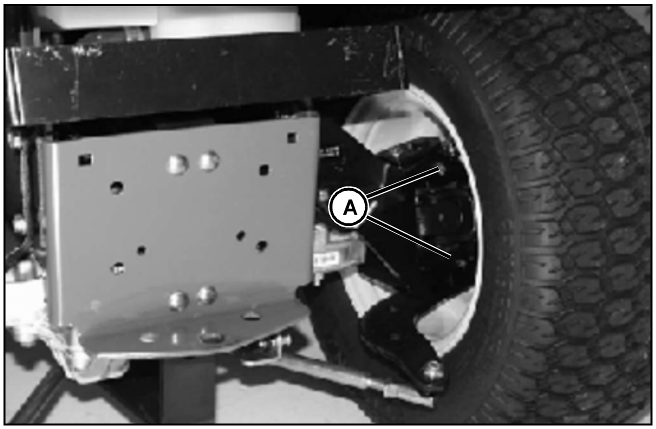
1. Lubricate front axle center pivot (A) with one or two shots of John Deere Extreme Pressure Grease or an equivalent.



M97150

Rear Steering Pivot Lubrication - AWS

1. Lubricate two rear steering pivots, lubrication fittings (A) on each side of machine, with one or two shots of John Deere Extreme Pressure Grease or an equivalent until grease comes out of spindle. Wipe off excess.



M97140

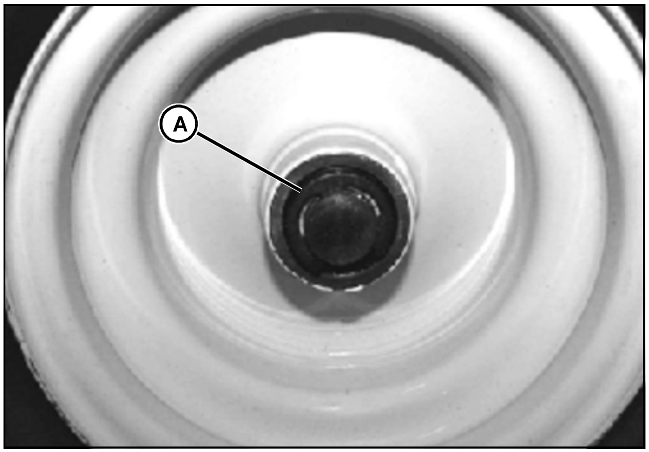
Front Wheel Removal and Installation

Removal:

CAUTION: Avoid Injury! MACHINE MAY SHIFT SUDDENLY. When supporting machine, be sure to place stands so that machine cannot tilt on front axle pivot.

1. Raise front of machine, and support both sides of front axle beam using suitable stands.

2. Remove plastic cap from wheel hub.



M95638

3. Remove E-ring (A) from end of axle.

4. Remove wheel.

Installation:

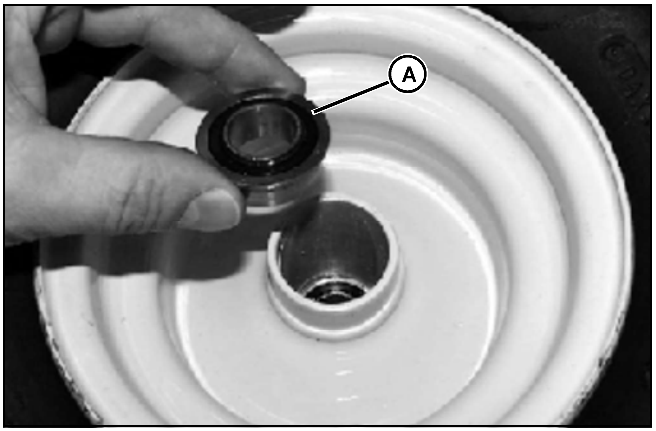
Installation is the reverse of removal.

Front Wheel Bearing Removal and Installation

Removal:

1. Remove wheel.

2. Inspect bearings for smooth operation, wear, or damage. Replace if needed.



M95639

3. Using a suitable puller, remove bearing (A) from wheel hub.

IMPORTANT: Avoid damage! If bearings are loose in wheel hub replace wheel.

Installation:

Installation is the reverse of removal.

- Apply a small amount of grease to bore of wheel hub or outside of bearing to ease assembly.
- Install bearing to wheel hub using a press.

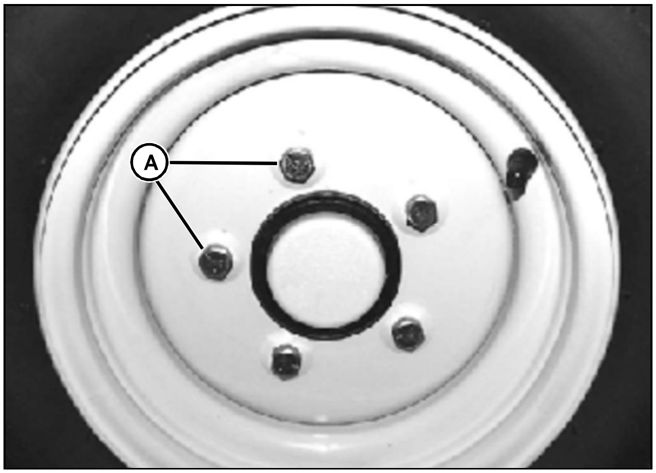
Rear Wheel Removal and Installation

Removal:

CAUTION: Avoid Injury! MACHINE MAY SHIFT SUDDENLY. When supporting machine, be sure to place stands so that machine cannot tilt on front axle pivot.

1. Raise rear of machine, and support machine frame using suitable stands.

NOTE: If only one wheel is being removed from the rear of the machine, the support stand used should be placed on the same side of the machine as the wheel being removed. Place the stand under the straight portion of the frame as far back as possible.



M99521

2. Remove five bolts (A) securing wheel and remove wheel.

Installation:

Installation is the reverse of removal.

- Tighten wheel bolts to 55 N•m (41 lb-ft).

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ATTACHMENTS SPECIFICATIONS

Specifications

Adjustment Specifications

Side-to-Side Blade Height Difference (Maximum) . . . . **3 mm (0.125 in.)**

Front-to-Rear Blade Height Difference
38, 44, 48 and 54-Inch . . . . **9 mm (0.125 - 0.375 in.) front lower than rear**
42C Mower . . . . **3 - 9 mm (0.125 - 0.375 in.) front lower than rear**

Repair Specifications

38-Inch Mower Deck

Spindle
Mounting Nut Torque . . . . **25 N•m (220 lb-in.)**
Sheave Nut Torque . . . . **140 N•m (103 lb-ft)**
Blade
Cap Screw Torque . . . . **75 N•m (55 lb-ft)**
Cutting Edge Width . . . . **0.40 mm (0.016 in.)**

42-Inch Convertible Mower Deck

Spindle
Mounting Nut Torque . . . . **27 N•m (20 lb-ft)**
Sheave Nut Torque . . . . **162 N•m (120 lb-ft)**
Lower Seal Installation Position . . . . **7.3 mm (0.29 in.) below hub flange**
Blade
Cap Screw Torque . . . . **62 N•m (46 lb-ft)**
Cutting Edge Width . . . . **0.40 mm (0.016 in.)**
Blade Indexing . . . . **90° ± 10°**

42-Inch Convertible Mower Deck

Spindle
Mounting Nut Torque . . . . **25 N•m (20 lb-ft)**
Sheave Nut Torque . . . . **162 N•m (120 lb-ft)**
Lower Seal Installation Position . . . . **7.3 mm (0.29 in.) below hub flange**
Blade
Cap Screw Torque . . . . **68 N•m (50 lb-ft)**
Cutting Edge Width . . . . **0.40 mm (0.016 in.)**

44-Inch Piranha™ Mower Deck

Spindle
Mounting Nut Torque . . . . **27 N•m (20 lb-ft)**
Sheave Nut Torque . . . . **162 N•m (120 lb-ft)**
Lower Seal Installation Position . . . . **7.3 mm (0.29 in.) below hub flange**
Blade
Cap Screw Torque . . . . **68 N•m (50 lb-ft)**
Cutting Edge Width . . . . **0.40 mm (0.016 in.)**

48-Inch Convertible and 54-Inch Mower Decks

Gauge Wheels
Roller Shaft Nut Torque . . . . **30 N•m (22 lb-ft)**
Idlers and Sheaves

Jack Sheave Nut Torque . . . . **136 N•m (100 lb-ft)**
Tensioning Idler Sheave Nut Torque . . . . **27 N•m (20 lb-ft)**

Spindle
Mounting Nut Torque . . . . **27 N•m (20 lb-ft)**
Sheave Nut Torque . . . . **145 N•m (106 lb-ft)**
Lower Seal Installation Position . . . . **7.3 mm (0.29 in.) below hub flange**

Blade
Cap Screw Torque . . . . **68 N•m (50 lb-ft)**
Cutting Edge Width . . . . **0.40 mm (0.016 in.)**

Tools and Materials

Tools

Special or Required Tools

Tool Name	Tool No.	Tool Use
Blade Height Gauge	TY15272	Use to check mower side-to-side level
Rotary Blade Balancer	JT07076	Use to balance blades
Torque Wrench	- - -	Use to install mower blades

Order tools according to information given in the U.S. SERVICEGARD™ Catalog or in the European Microfiche Tool Catalog (MTC).

Other Materials

Other Material

Part No.	Part Name	Part Use
M79292	MPG-2® Multipurpose Grease	Lubricate Spindles
T43512 / TY9473 / 242	LOCTITE® Thread Lock and Sealer (Medium Strength)	Apply to threads of set screws

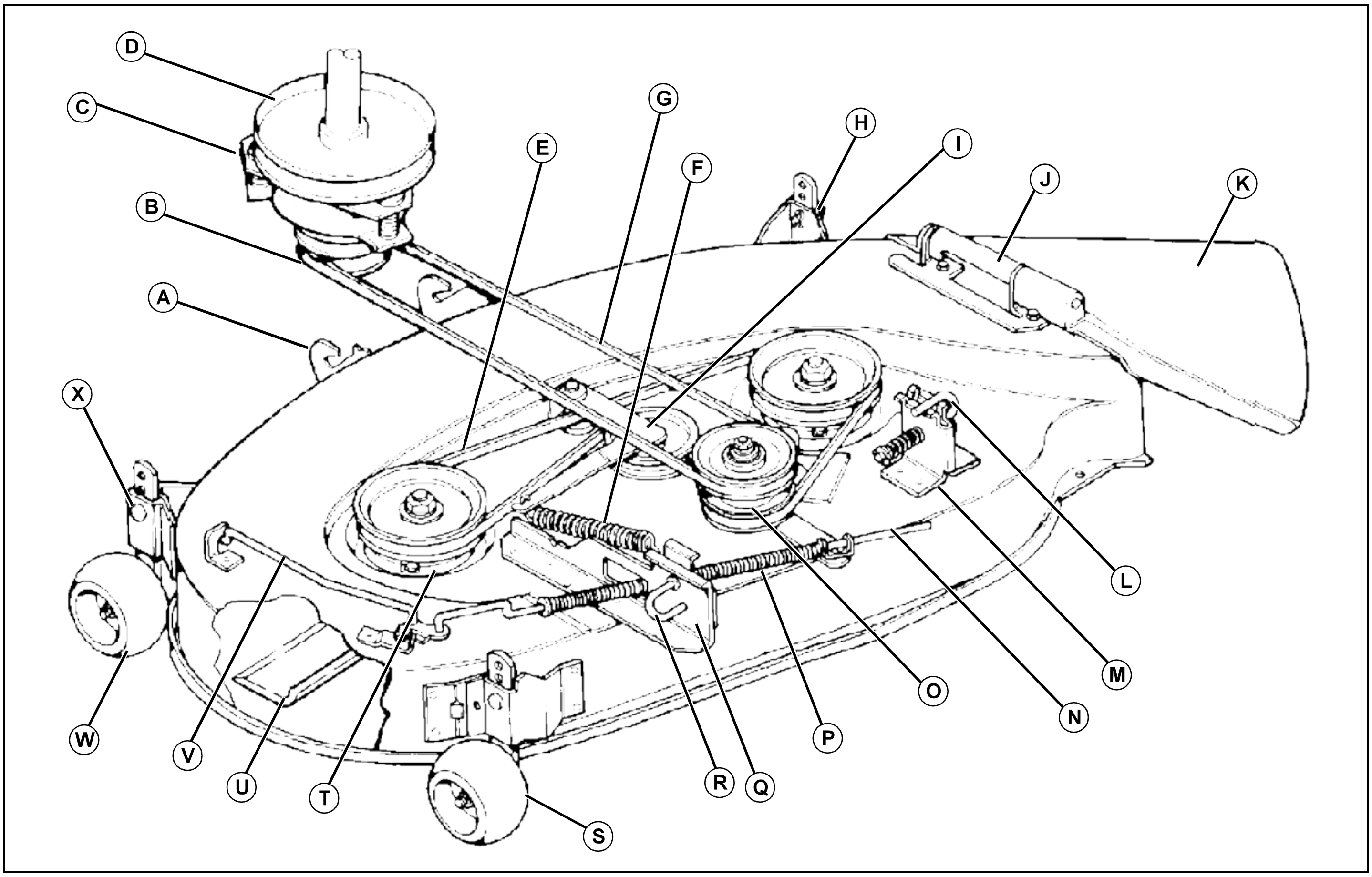
LOCTITE® is a registered trademark of the Loctite Corp.

MPG-2® is a registered trademark of DuBois USA

Component Location

38-Inch Mower Deck

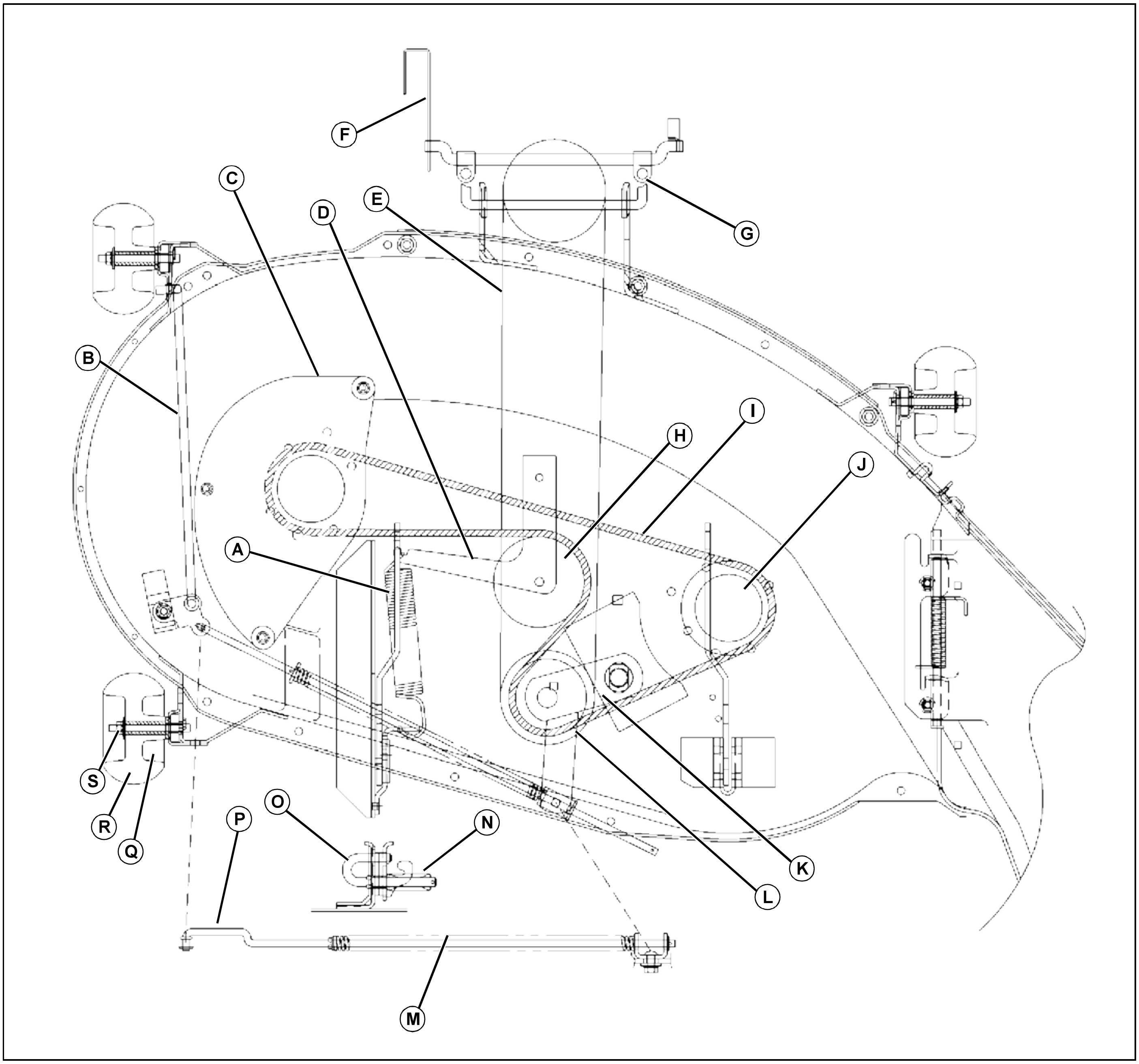
Component View



M45878

A - Front Draft Arm Hangers
B - PTO Drive Sheave
C - PTO Clutch
D - Traction Drive Sheave
E - Secondary Drive Belt
F - Secondary Drive Belt Idler Tensioning Spring
G - Primary Drive Belt
H - Spring Locking Pin
I - Secondary Belt Idler Arm Assembly
J - Hinge Assembly
K - Discharge Chute
L - Right J-Pin Assembly
M - Rear Draft Arm Attaching Bracket
N - Belt Tensioning Rod
O - Primary Jack Sheave Arm Assembly
P - Primary Belt Tensioning Spring
Q - Rear Draft Arm Attaching Bracket
R - Left J-Pin Assembly
S - Rear Gauge Wheel Assembly
T - Spindle
U - Blade
V - Quick-Release Belt Tensioning Handle
W - Front Gauge Wheel Assembly
X - Drilled Pin

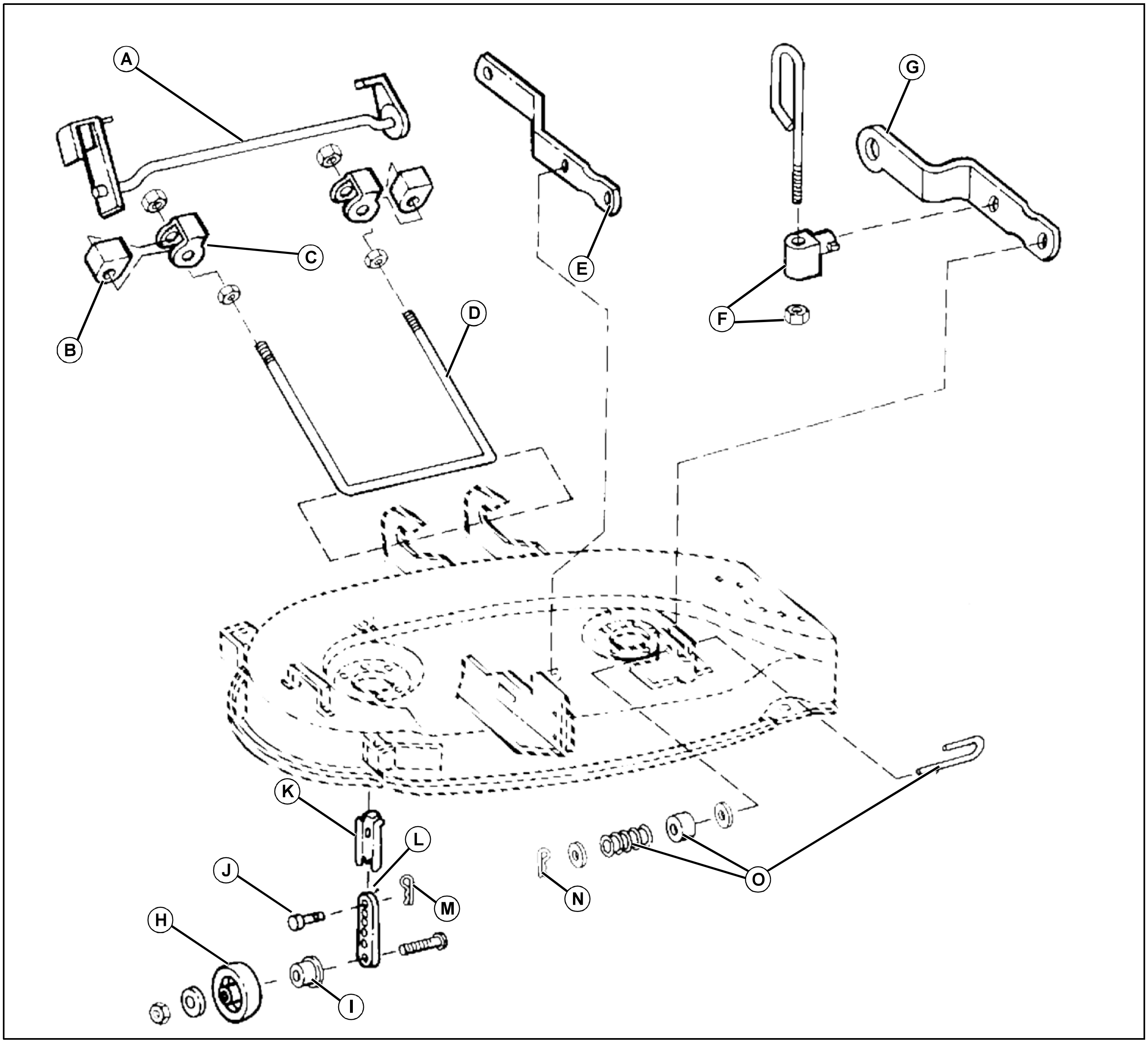
Overall View



M99532

- **A - Tensioning Spring**
- **B - Belt Tensioning Handle**
- **C - Belt Shield**
- **D - Secondary Idler Arm**
- **E - Primary Drive Belt**
- **F - Pivot Lock Lever**
- **G - Front Draft Rod**
- **H - Secondary Drive Belt Idler Sheave**
- **I - Secondary Drive Belt**
- **J - Spindle (2 used)**
- **K - Primary Jack Sheave Arm**
- **L - Primary Jack Sheave**
- **M - Primary Belt Tensioning Spring**
- **N - Spring**
- **O - J-Pin Assembly (2 used)**
- **P - Primary Drive Belt Tensioning Rod**
- **Q - Bushing**
- **R - Gauge Wheel (3 used)**
- **S - Gauge Wheel Shaft**

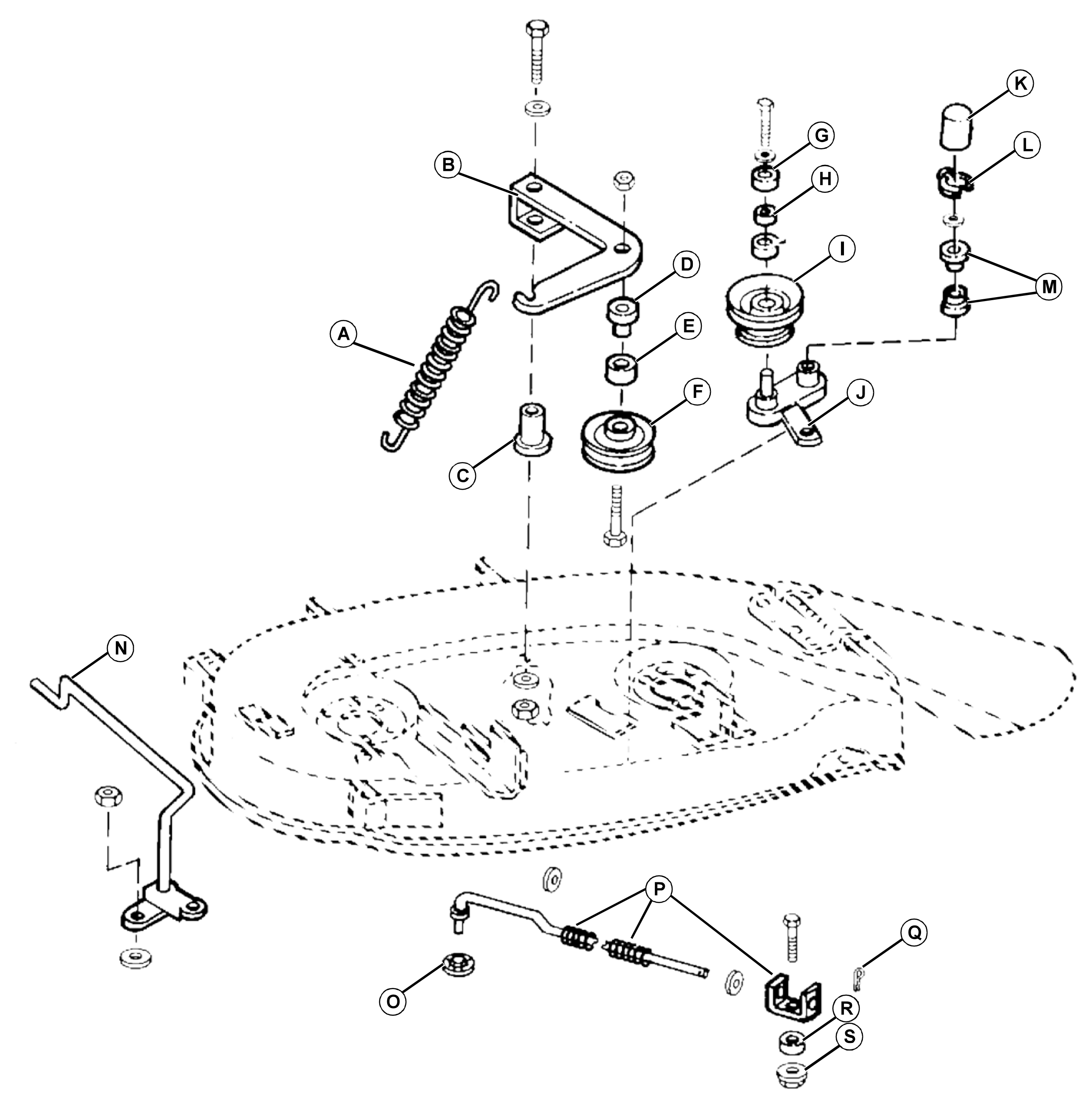
Draft Arms and Gauge Wheels



M82894AE

- **A - Pivot**
- **B - Spacer (2 used)**
- **C - Clevis (2 used)**
- **D - Front Draft Rod**
- **E - Rear Draft Arm (Left)**
- **F - Lift Link Assembly (2 used)**
- **G - Rear Draft Arm (Right)**
- **H - Gauge Wheel (3 used)**
- **I - Bushing (3 used)**
- **J - Pin (3 used)**
- **K - Clip (3 used)**
- **L - Strap (3 used)**
- **M - Spring Pin (3 used)**
- **N - Cotter Pin (2 used)**

Idlers and Sheaves

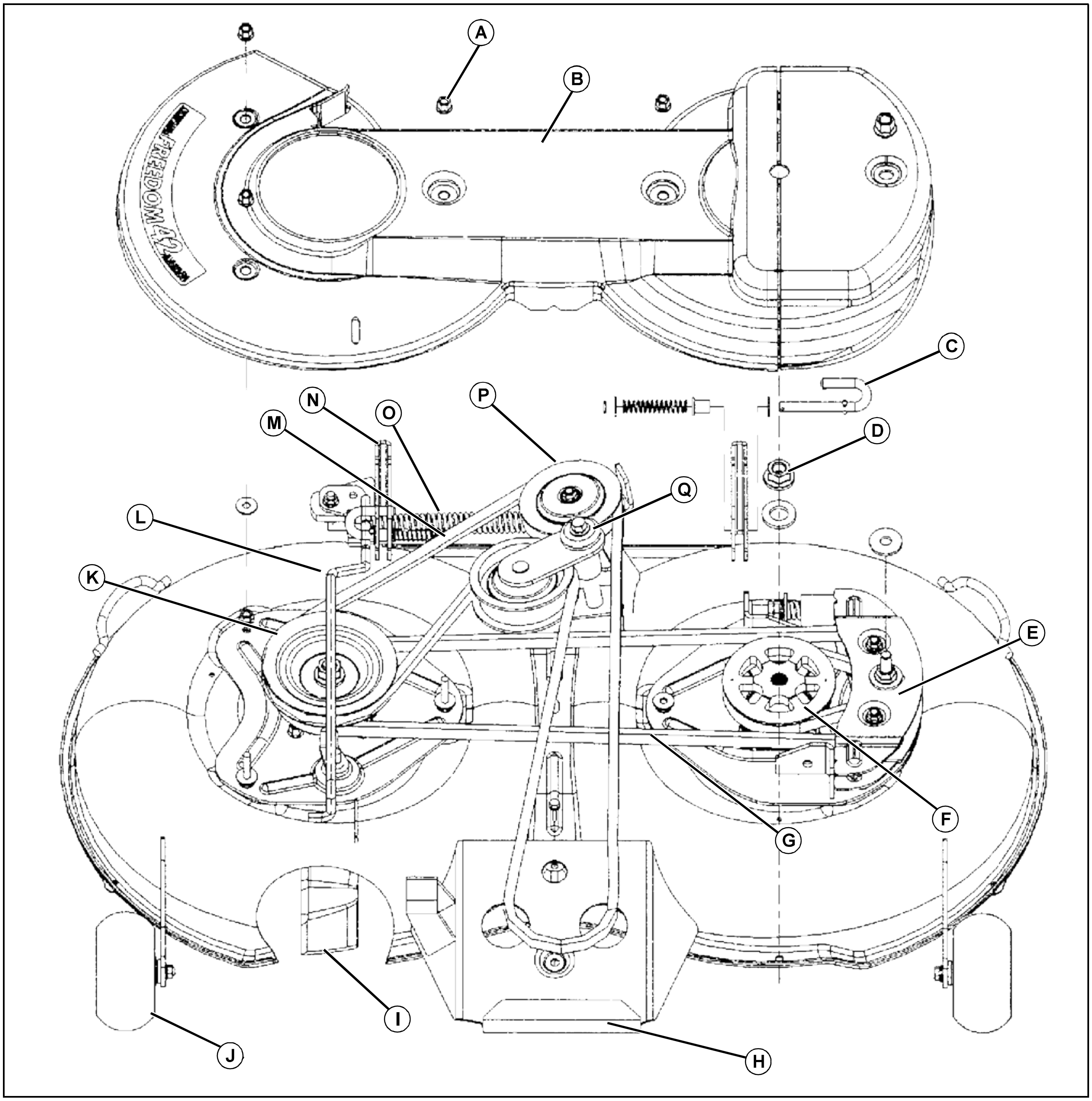


M54670AO

A - Idler Tensioning Spring
B - Secondary Idler Arm
C - Idler Arm Bushing
D - Spacer
E - Ball Bearing
F - Idler Sheave
G - Ball Bearing (2 used)
H - Spacer
I - Primary Jack Sheave
J - Primary Jack Sheave Arm
K - Cap
L - Snap Ring
M - Bushings
N - Quick-Release Belt Tensioning Handle
O - Retainer
P - Primary Tensioning Spring Assembly
Q - Spring Pin
R - Bushing
S - Flange Nut

42-Inch Mulching Mower Deck

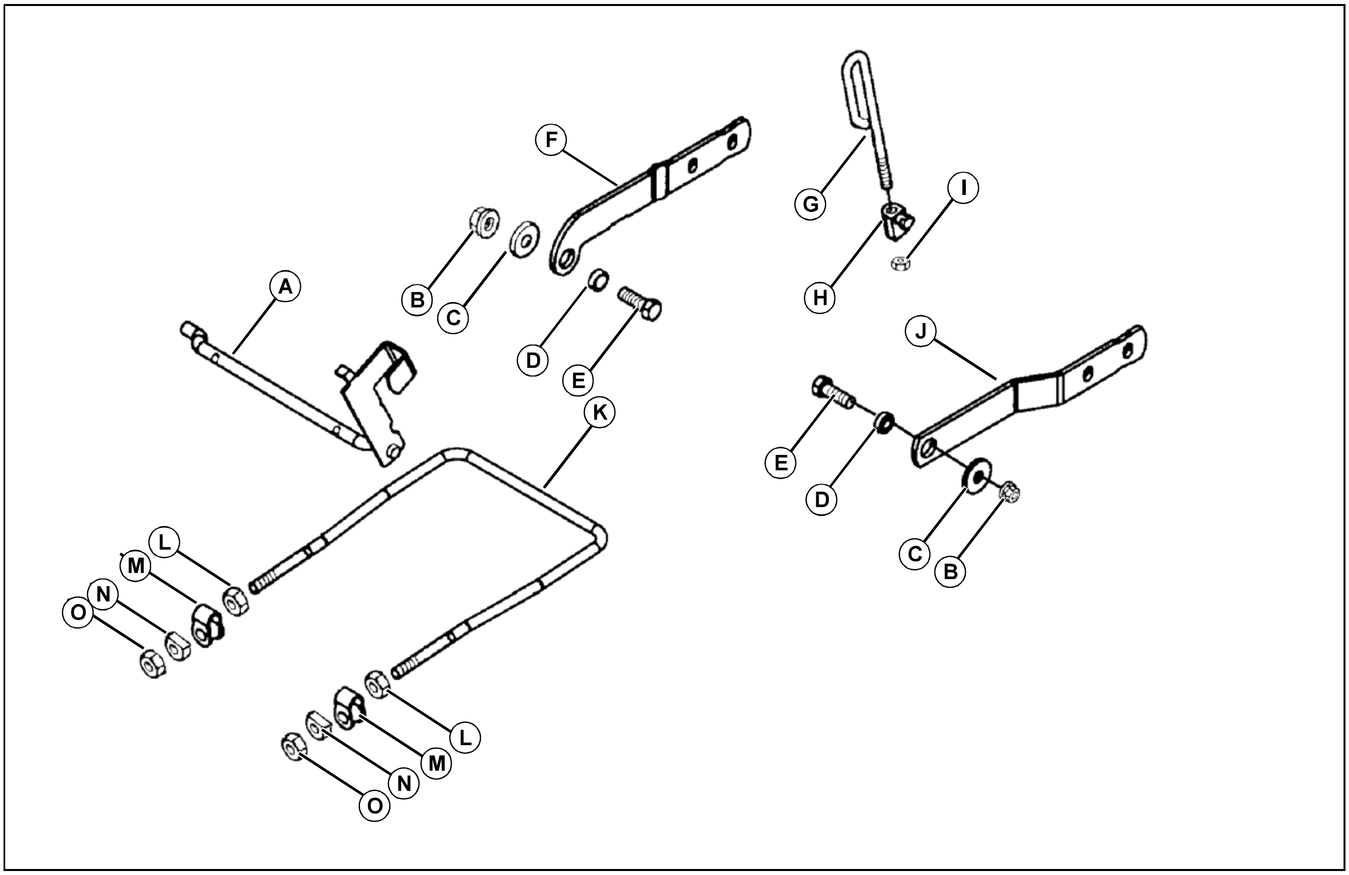
Overall View



MX9634

- **A - Nut**
- **B - Belt Shield**
- **C - "J" Pin Assembly**
- **D - Nut**
- **E - Idler Support Plate**
- **F - Drive Sprocket**
- **G - Timing Belt**
- **H - Bracket, Front Draft**
- **I - Mower Blade**
- **J - Gauge Wheel**
- **K - Sheave**
- **L - Tensioner Handle**
- **M - Drive Belt**
- **N - Rear Draft Arm Bracket**
- **O - Tensioner Rod**
- **P - Flat Idler Sheave**
- **Q - V-Idler Sheave**
- **R - Tensioner Bracket**

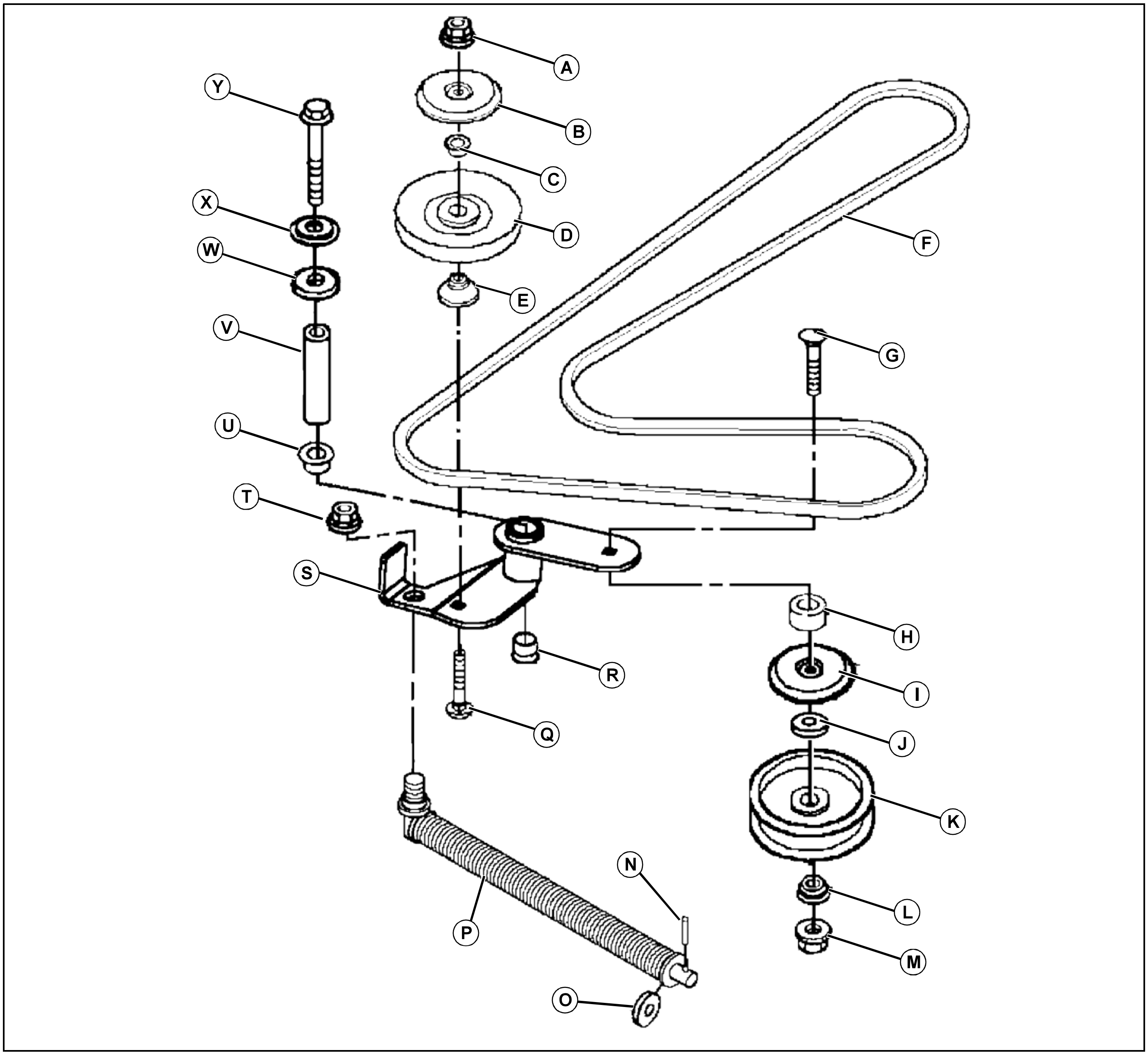
Draft Arms



M99559

A - **Pivot**
B - **Spacer (2 used)**
C - **Clevis (2 used)**
D - **Front Draft Rod**
E - **Rear Draft Arm (Left)**
F - **Lift Link Assembly (2 used)**
G - **Rear Draft Arm (Right)**
H - **Gauge Wheel**
I - **Bushing (4 used)**
J - **Pin (4 used)**
K - **Clip (4 used)**
L - **Strap (4 used)**
M - **Spring Pin (4 used)**
N - **Cotter Pin (2 used)**
O - **J-pin Assembly (2 used)**

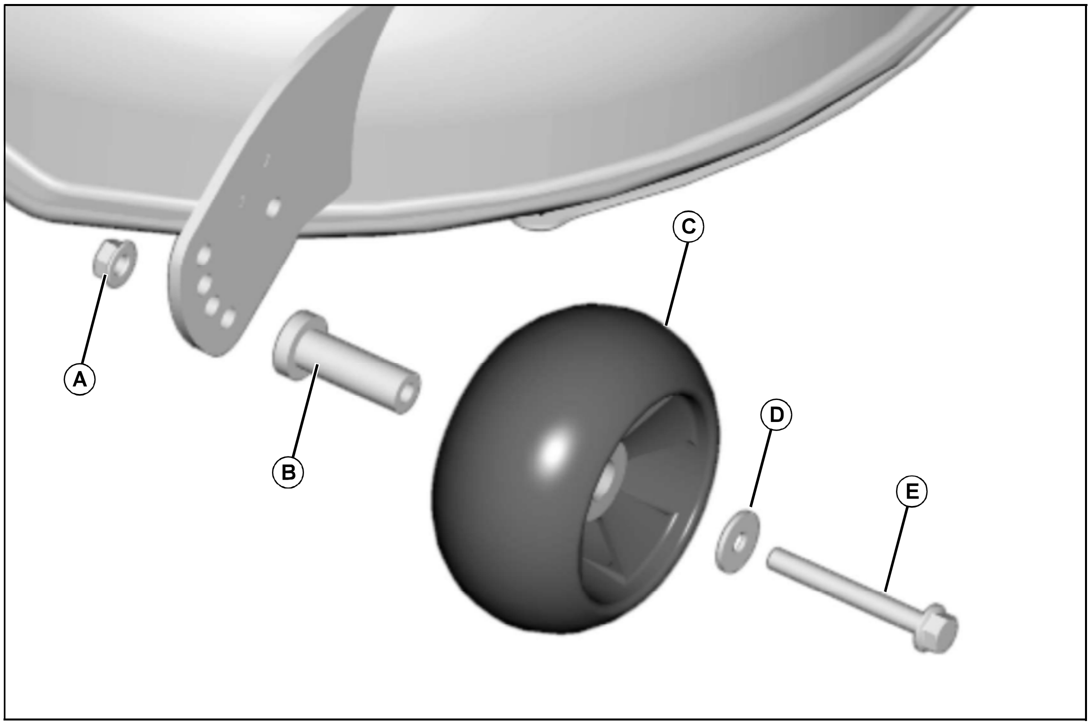
Idlers and Sheaves



MX9633

- **A - Flange Nut**
- **B - Shield**
- **C - Bushing**
- **D - Idler Sheave**
- **E - Spacer**
- **F - Drive Belt**
- **G - Carriage Bolt**
- **H - Bushing**
- **I - Shield**
- **J - Washer**
- **K - Flat Idler Sheave**
- **L - Bushing**
- **M - Flange Nut**
- **N - Groove Pin**
- **O - Washer**
- **P - Tensioner Rod**
- **Q - Carriage Bolt**
- **R - Bushing**
- **S - Idler Bracket**
- **T - Flange Nut**
- **U - Bushing**
- **V - Tube**
- **W - Washer**
- **X - Cap**
- **Y - Screw**

Gauge Wheels

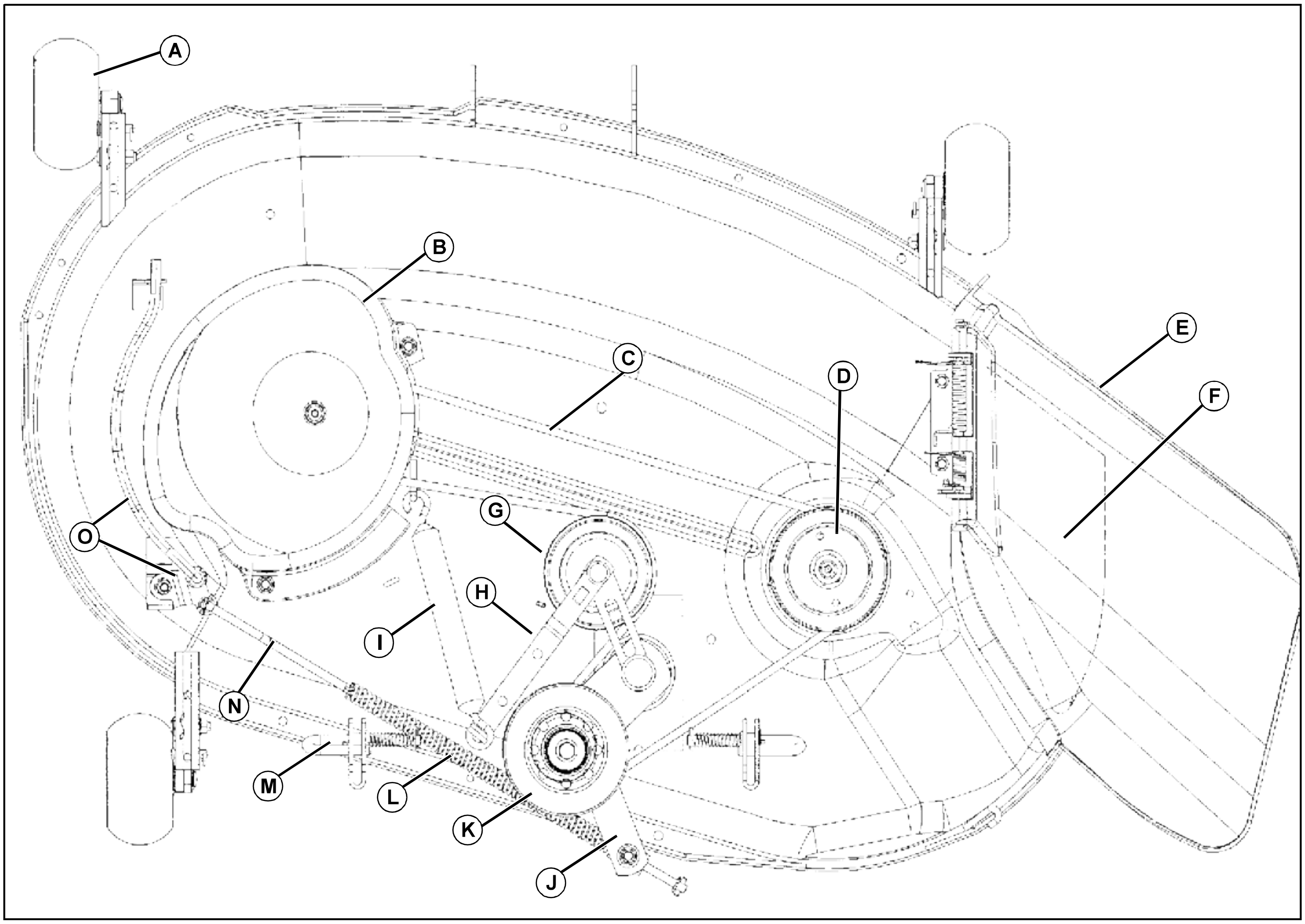


MX7590

- **A - Locknut**
- **B - Bushing**
- **C - Gauge Wheel**
- **D - Washer**
- **E - Screw**

42-Inch Convertible Mower Deck

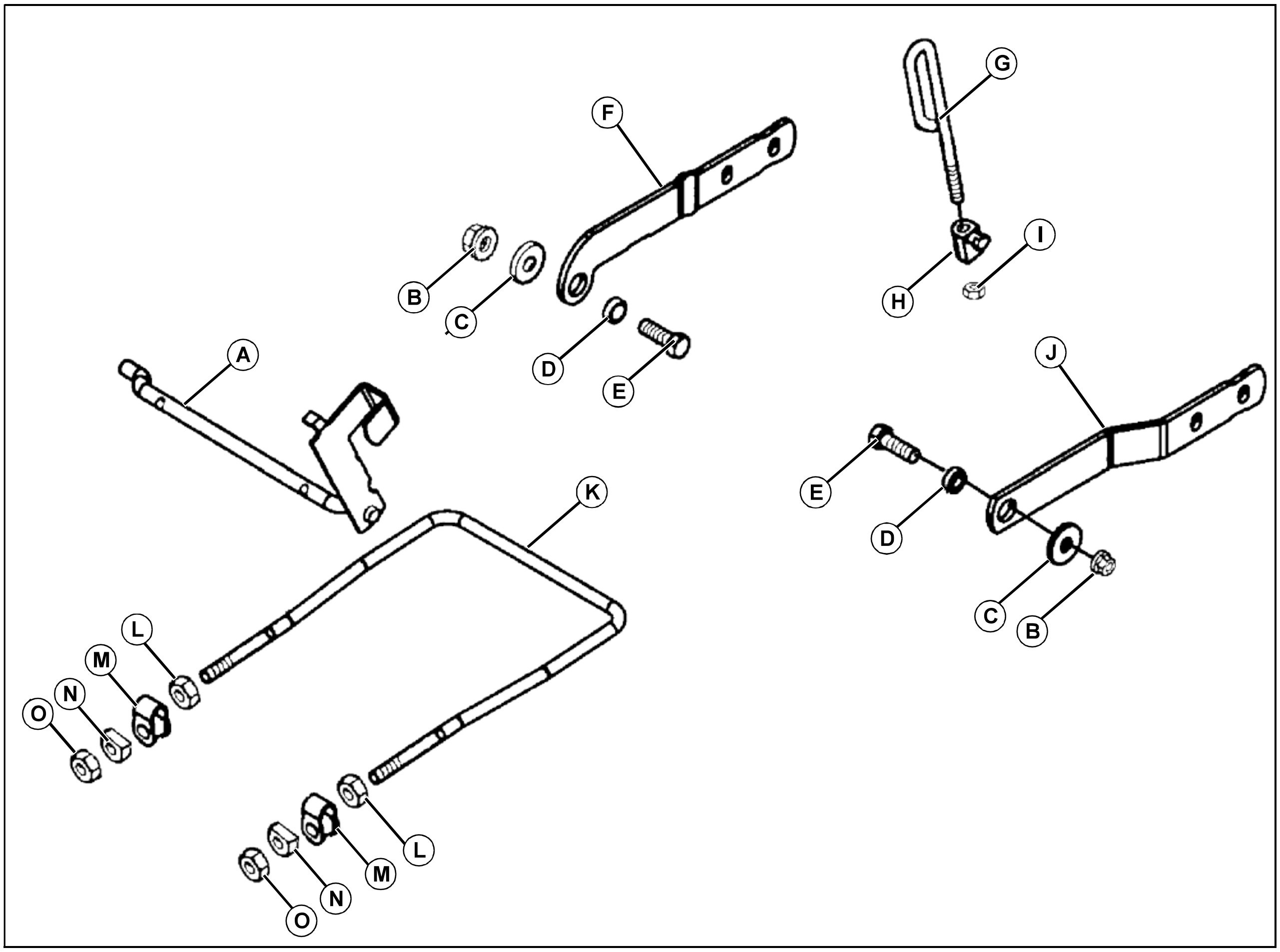
Component Location



M99542

A - Gauge Wheel
B - Shield
C - Secondary Drive Belt
D - Spindle Sheave
E - Chute Guard
F - Inner Discharge Chute
G - Flat Idler Sheave
H - Secondary Spring Arm
I - Idler Spring
J - Jacksheave Pivot Arm
K - Jacksheave
L - Tensioner Spring
M - “J” Pin Assembly
N - Tensioner Rod
O - Tensioner Handle

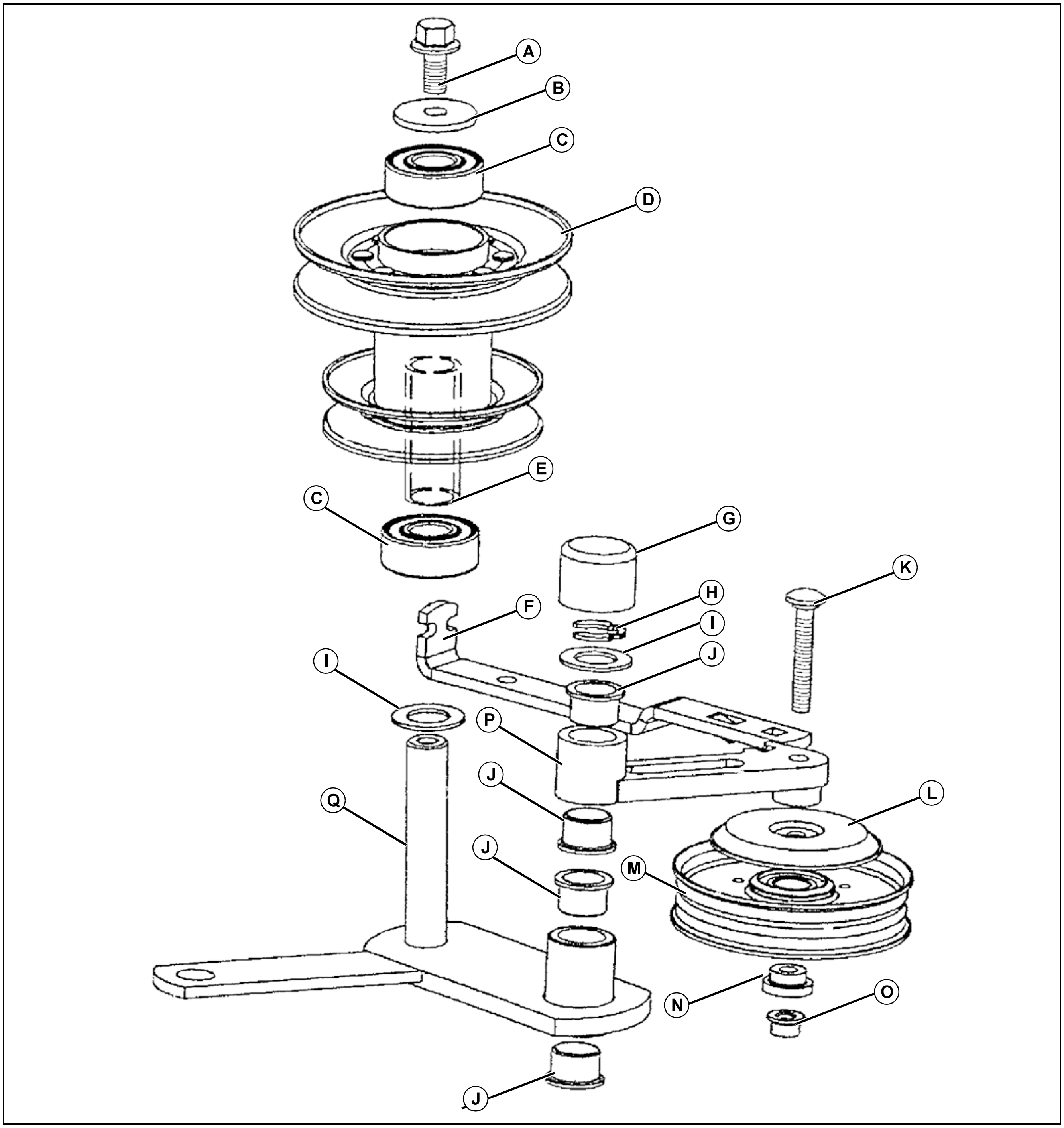
Draft Arms



M99559

A - Pivot
B - Spacer (2 used)
C - Clevis (2 used)
D - Front Draft Rod
E - Rear Draft Arm (Left)
F - Lift Link Assembly (2 used)
G - Rear Draft Arm (Right)
H - Gauge Wheel (4 used)
I - Bushing (4 used)
J - Pin (4 used)
K - Clip (4 used)
L - Strap (4 used)
M - Spring Pin (4 used)
N - Cotter Pin (2 used)
O - J-Pin Assembly (2 used)

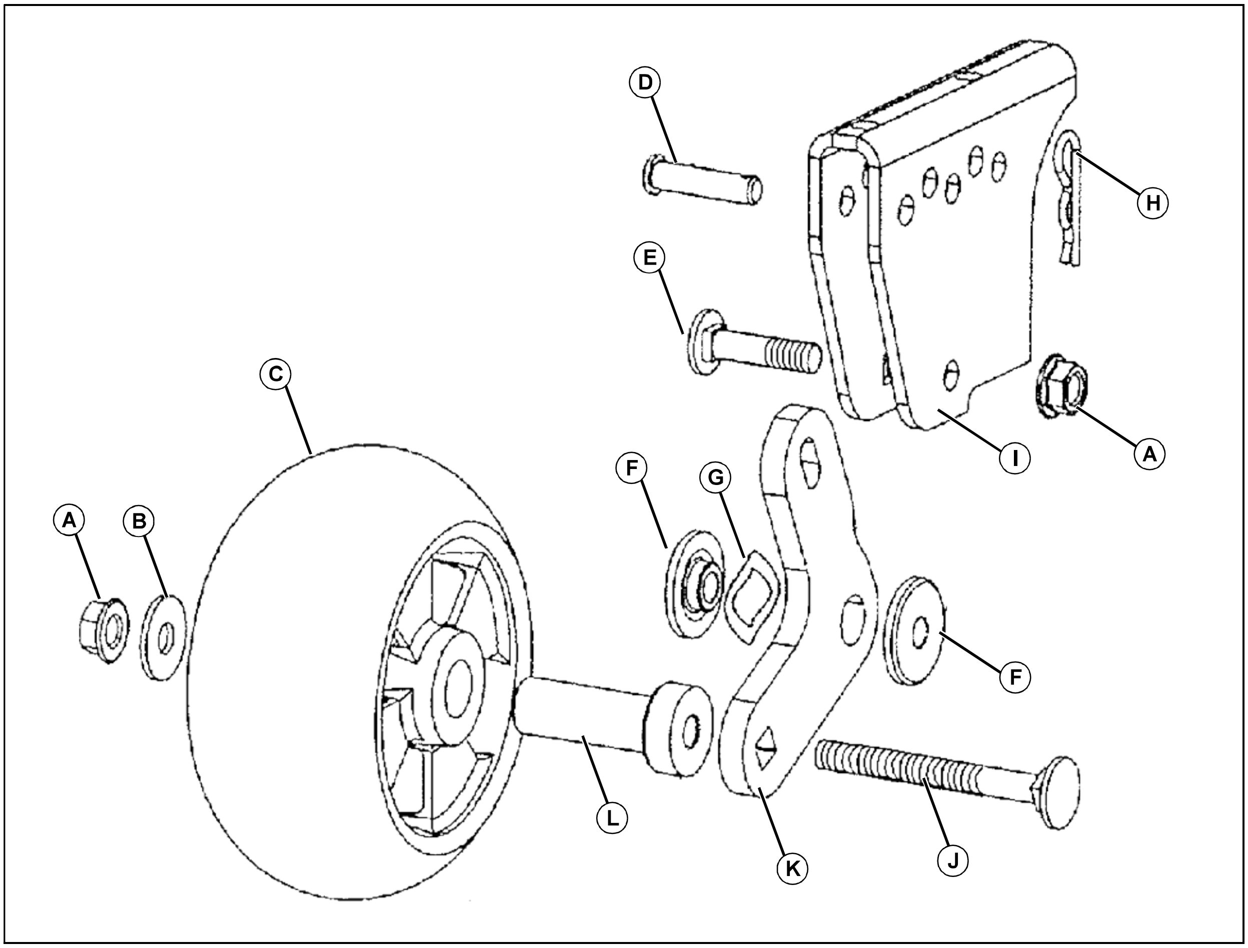
Idlers and Sheaves



M99543

- A - Cap Screw
- B - Washer
- C - Bearing
- D - Jack Sheave
- E - Spacer
- F - Secondary Spring Arm
- G - Cap
- H - E-Clip
- I - Washer
- J - Bushing
- K - Carriage Bolt
- L - Shield
- M - Flat Idler Sheave
- N - Bushing
- O - Nut
- P - Idler Arm
- Q - Jacksheave Pivot Arm

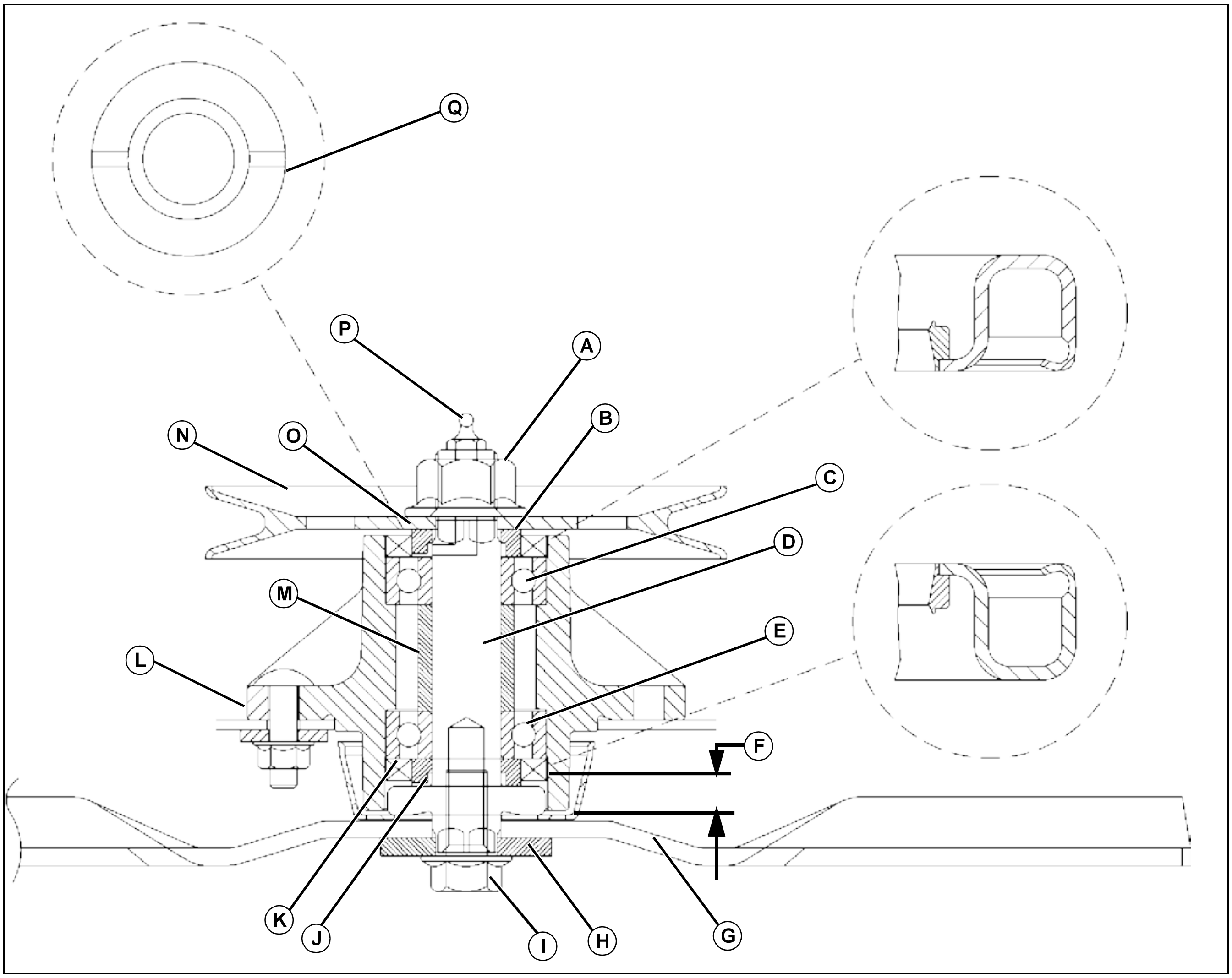
Gauge Wheels



M99544

A - Locknut
B - Washer
C - Gauge Wheel
D - Pin
E - Carriage Bolt
F - Bushing
G - Wave Washer
H - Spring Locking Pin
I - Bracket (Welded)
J - Carriage Bolt
K - Gauge Wheel Arm
L - Bushing

Spindle - Cross Section

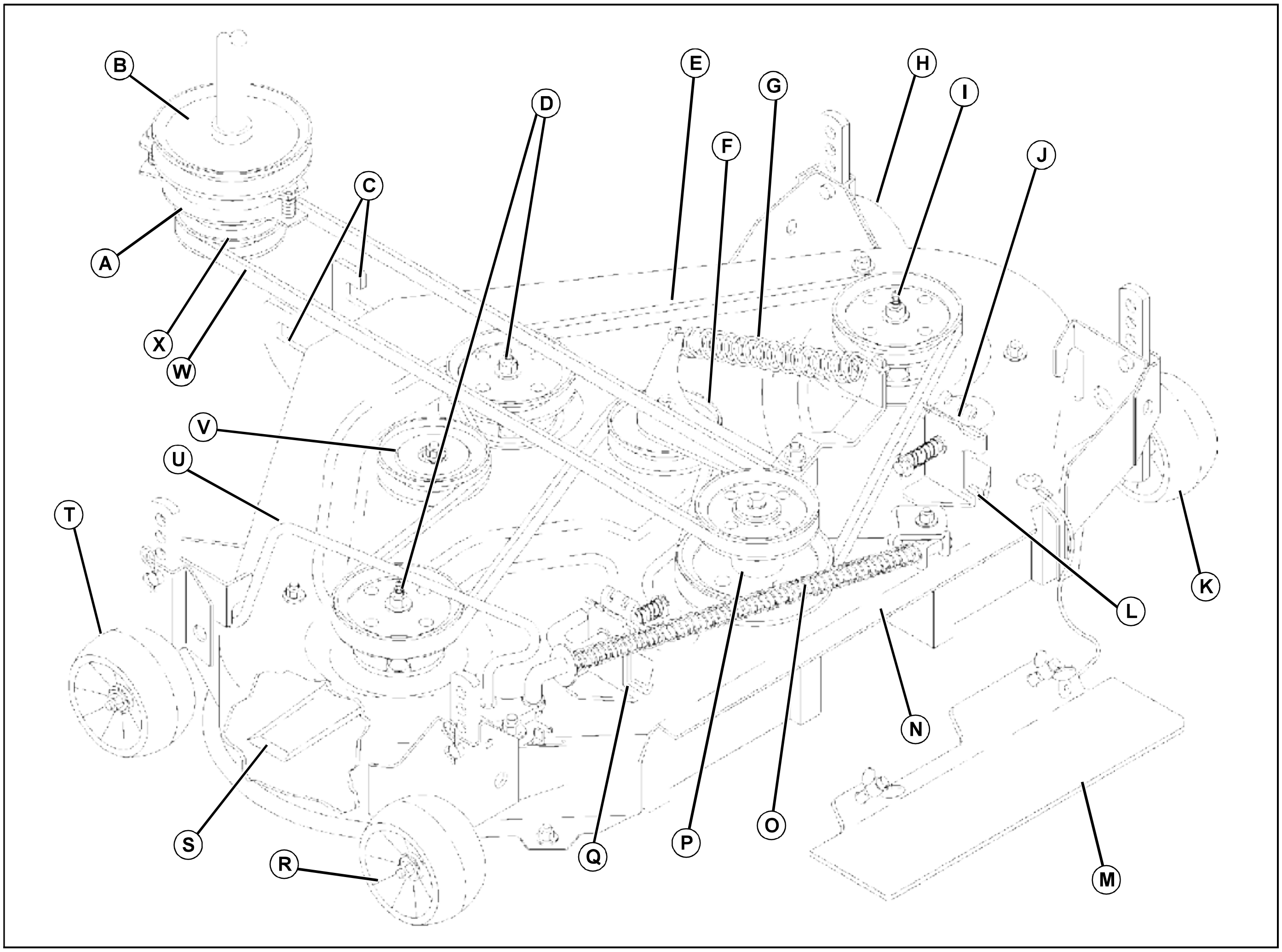


M99546

A - Nut
B - Upper Seal Ring
C - Upper Bearing
D - Spindle Shaft
E - Lower Bearing
F - Seal Depth - 7.3 mm (0.29 in.)
G - Blade
H - Blade Washer
I - Cap Screw
J - Lower Seal Ring
K - Lower Seal
L - Spindle Housing
M - Spacer
N - Spindle Sheave
O - Upper Seal
P - Lubrication Fitting
Q - Grease Notch

44-Inch Piranha Mower Deck

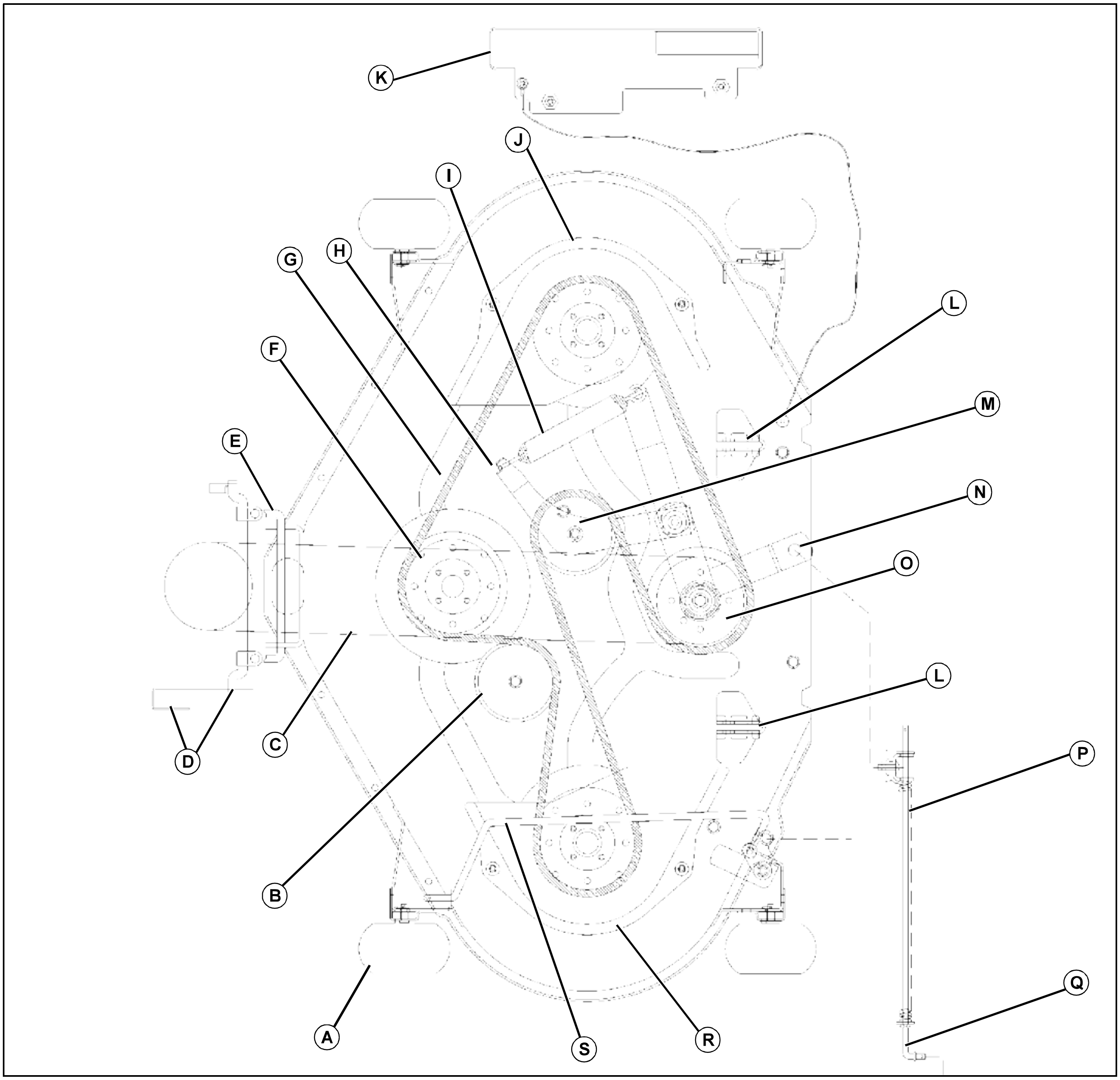
Component View



M99533

- **A - PTO Clutch**
- **B - Traction Drive Sheave**
- **C - Front Draft Arm Hangers**
- **D - Greaseable Spindles**
- **E - Secondary Drive Belt**
- **F - Secondary Drive Belt Idler**
- **G - Secondary Drive Belt Tensioning Spring**
- **H - Right Front Gauge Wheel**
- **I - Greaseable Spindle**
- **J - J-Pin Assembly**
- **K - Right Rear Gauge Wheel**
- **L - Rear Draft Arm Attaching Bracket**
- **M - Deflector**
- **N - Discharge Chute**
- **O - Primary Belt Tensioning Spring**
- **P - Jack Sheave Assembly**
- **Q - Rear Draft Arm Bracket**
- **R - Left Rear Gauge Wheel**
- **S - Blade**
- **T - Left Front Gauge Wheel**
- **U - Quick-Release Belt Tensioning Handle**
- **V - Fixed Idler Sheave**
- **W - Primary Drive Belt**
- **X - PTO Drive Sheave**

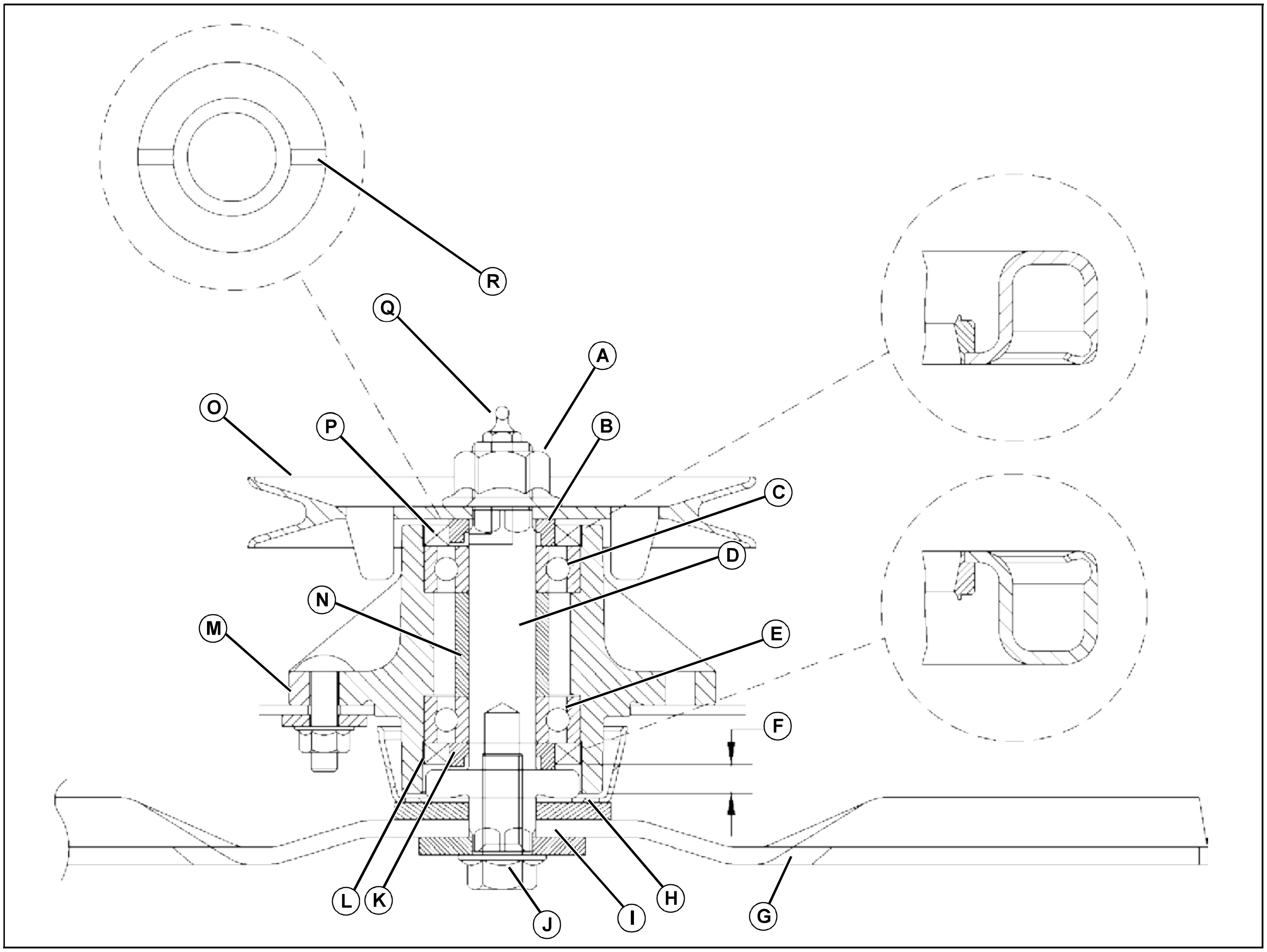
Overall View



M82734AE

A - Gauge Wheel
B - Fixed Idler Sheave
C - Primary Drive Belt
D - Lock Lever
E - Front Draft Rod
F - Spindle (Driven Sheave)
G - Secondary Drive Belt
H - Secondary Drive Belt Idler Arm
I - Secondary Drive Belt Tensioning Spring
J - Right Belt Cover
K - Deflector
L - Rear Draft Arm Attaching Bracket
M - Idler Sheave
N - Idler Pivot Arm
O - Jack Sheave
P - Primary Belt Tensioning Spring
Q - Primary Belt Tensioning Rod
R - Left Belt Cover
S - Belt Tensioning Handle

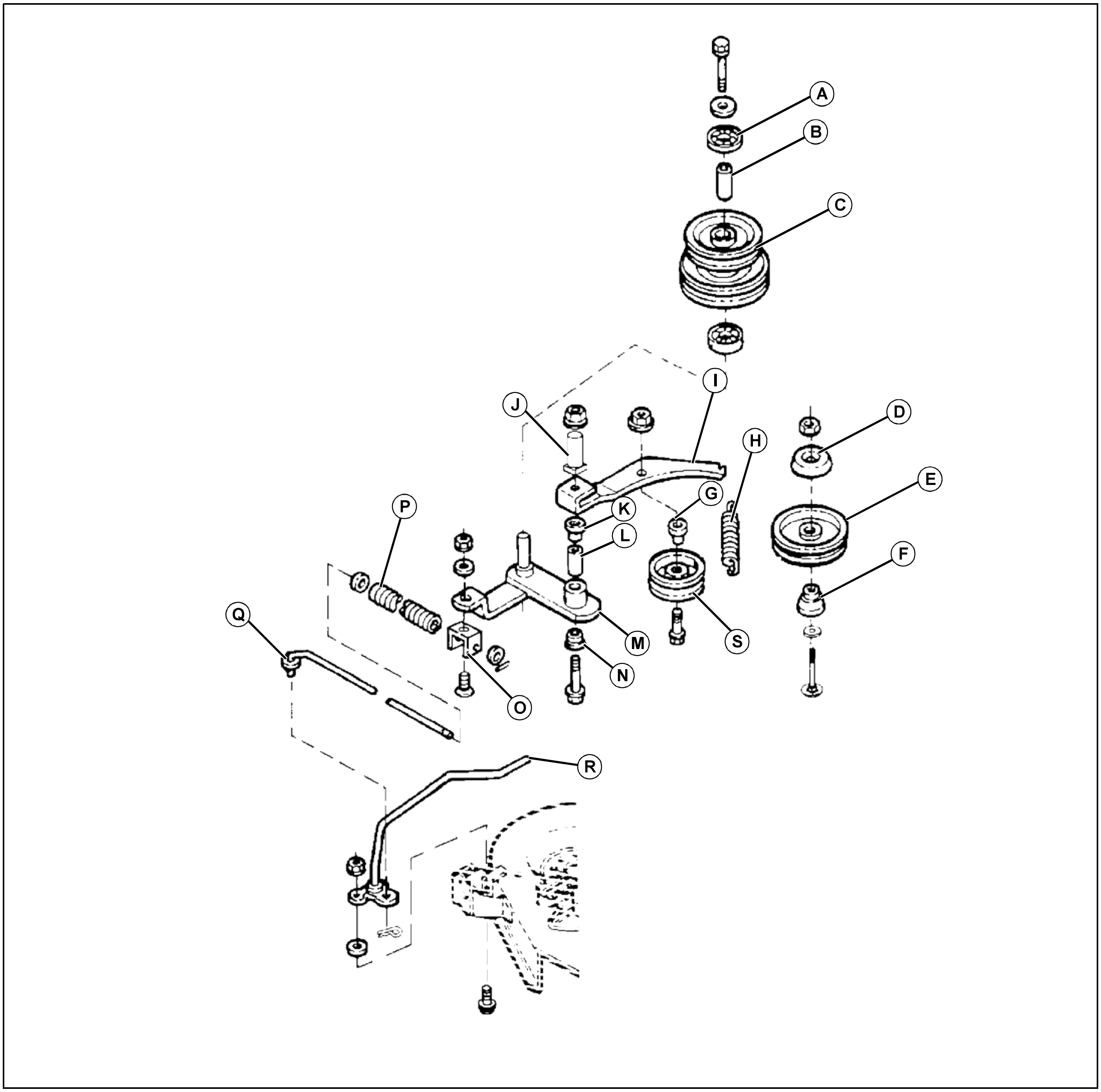
Spindle - Cross Section



M99535

- **A - Nut**
- **B - Upper Seal Ring**
- **C - Upper Bearing**
- **D - Spindle Shaft**
- **E - Lower Bearing**
- **F - Seal Depth - 7.3 mm (0.29 in.)**
- **G - Blade**
- **H - Blade Washer**
- **I - Blade Washer**
- **J - Cap Screw**
- **K - Lower Seal Ring**
- **L - Lower Seal**
- **M - Spindle Housing**
- **N - Spacer**
- **O - Spindle Sheave**
- **P - Upper Seal**
- **Q - Lubrication Fitting**
- **R - Grease Notch**

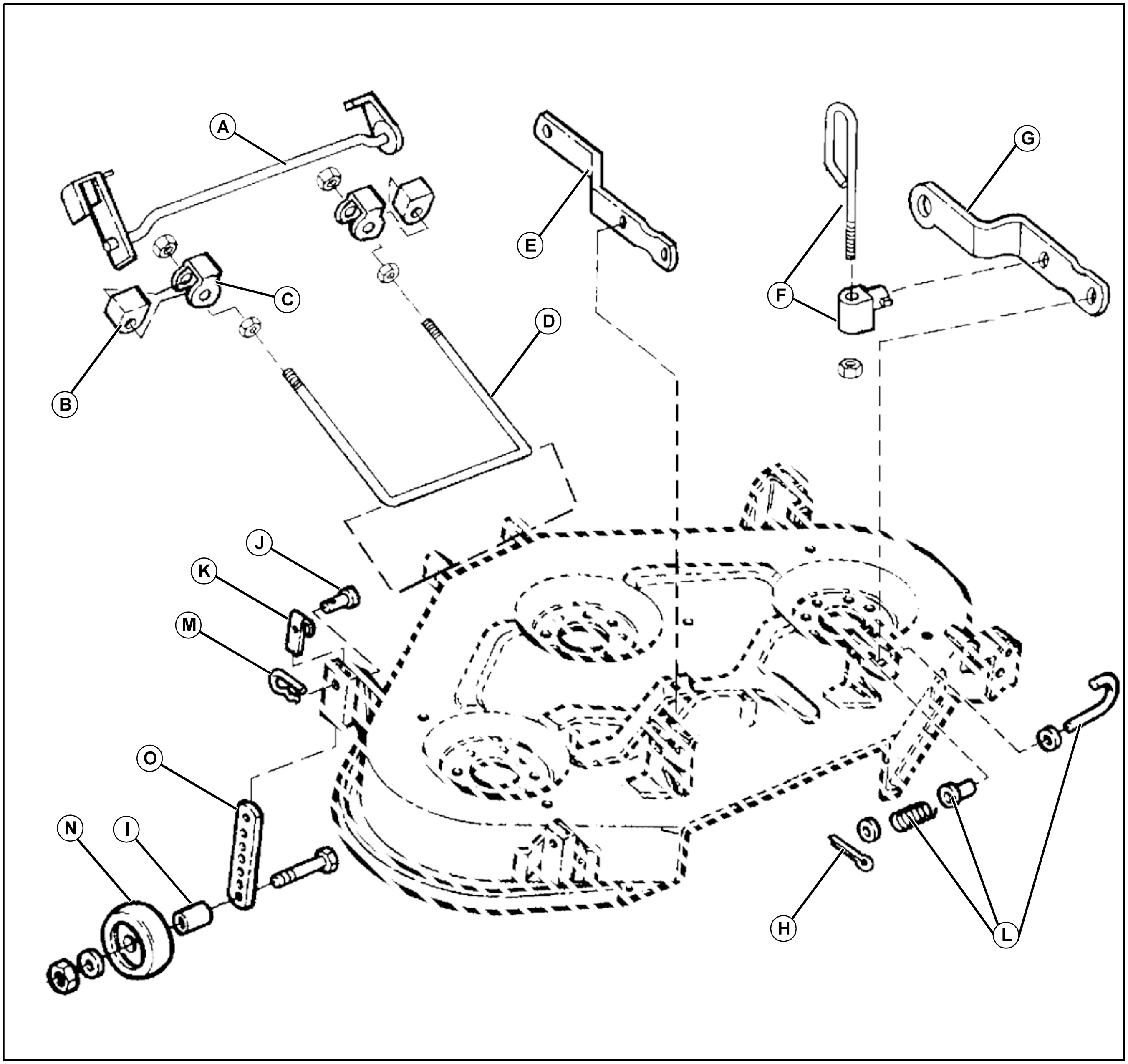
Idlers and Sheaves



M82736A

A - Ball Bearing (2 used)
B - Spacer
C - Jack Sheave
D - Shield
E - Fixed Idler Sheave
F - Spacer
G - Spacer
H - Secondary Drive Belt Tensioning Spring
I - Secondary Drive Belt Idler Arm
J - Bushing
K - Bushing
L - Bushing
M - Jack Sheave Arm
N - Bushing
O - Clevis
P - Primary Belt Tensioning Spring
Q - Primary Belt Tensioning Rod
R - Belt Tensioning Handle
S - Secondary Drive Belt Idler Sheave

Draft Arms and Gauge Wheels

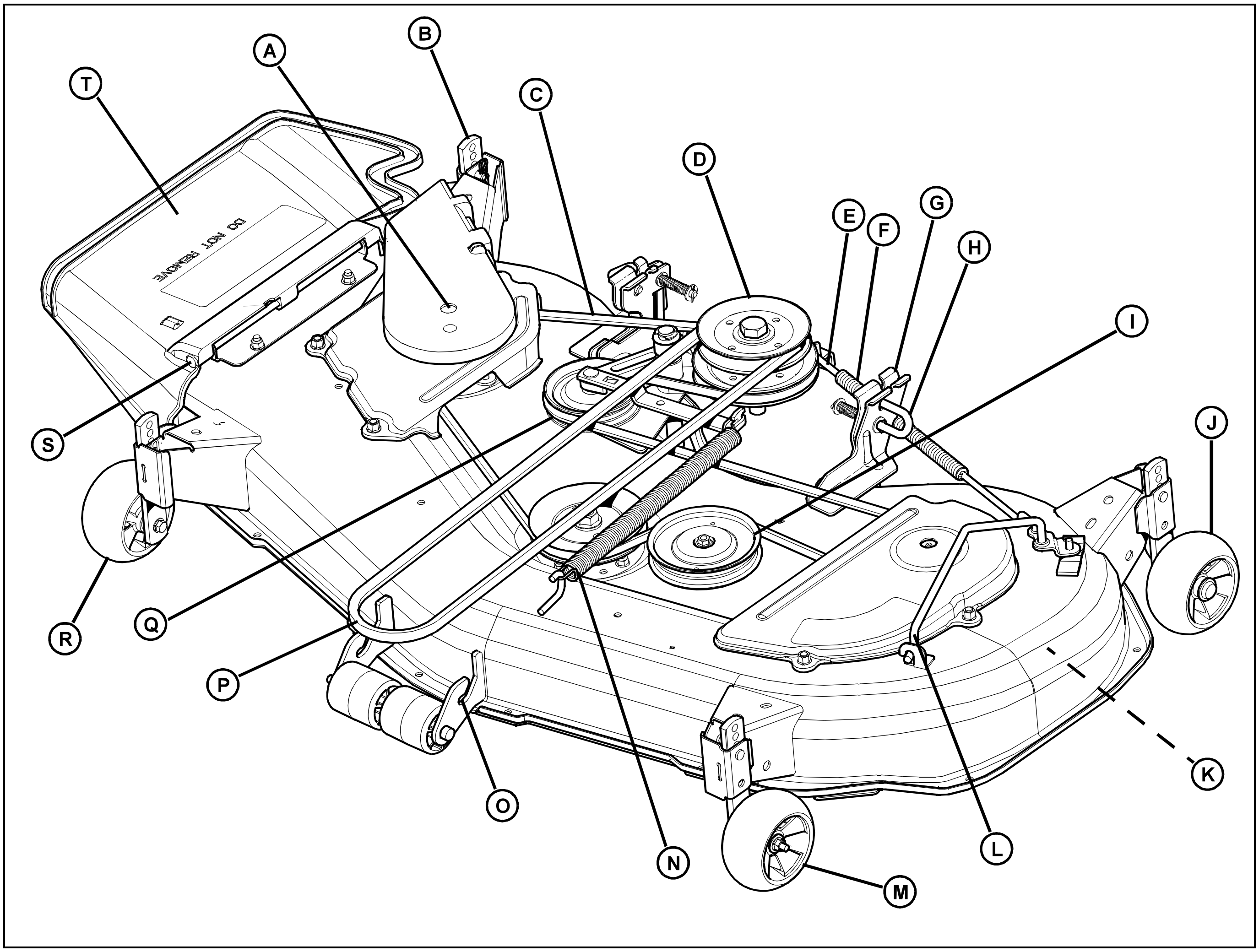


M82735AO

- **A - Pivot**
- **B - Rear Draft Arm (Left)**
- **C - Bushing (4 used)**
- **D - Spring Pin (4 used)**
- **E - Spacer (2 used)**
- **F - Lift Link Assembly (2 used)**
- **G - Pin (4 used)**
- **H - Cotter Pin (2 used)**
- **I - Clevis (2 used)**
- **J - Rear Draft Arm (Right)**
- **K - Clip (4 used)**
- **L - J-Pin Assembly (2 used)**
- **M - Front Draft Arm**
- **N - Gauge Wheel (4 used)**
- **O - Strap (4 used)**

48-Inch Convertible Mower Deck

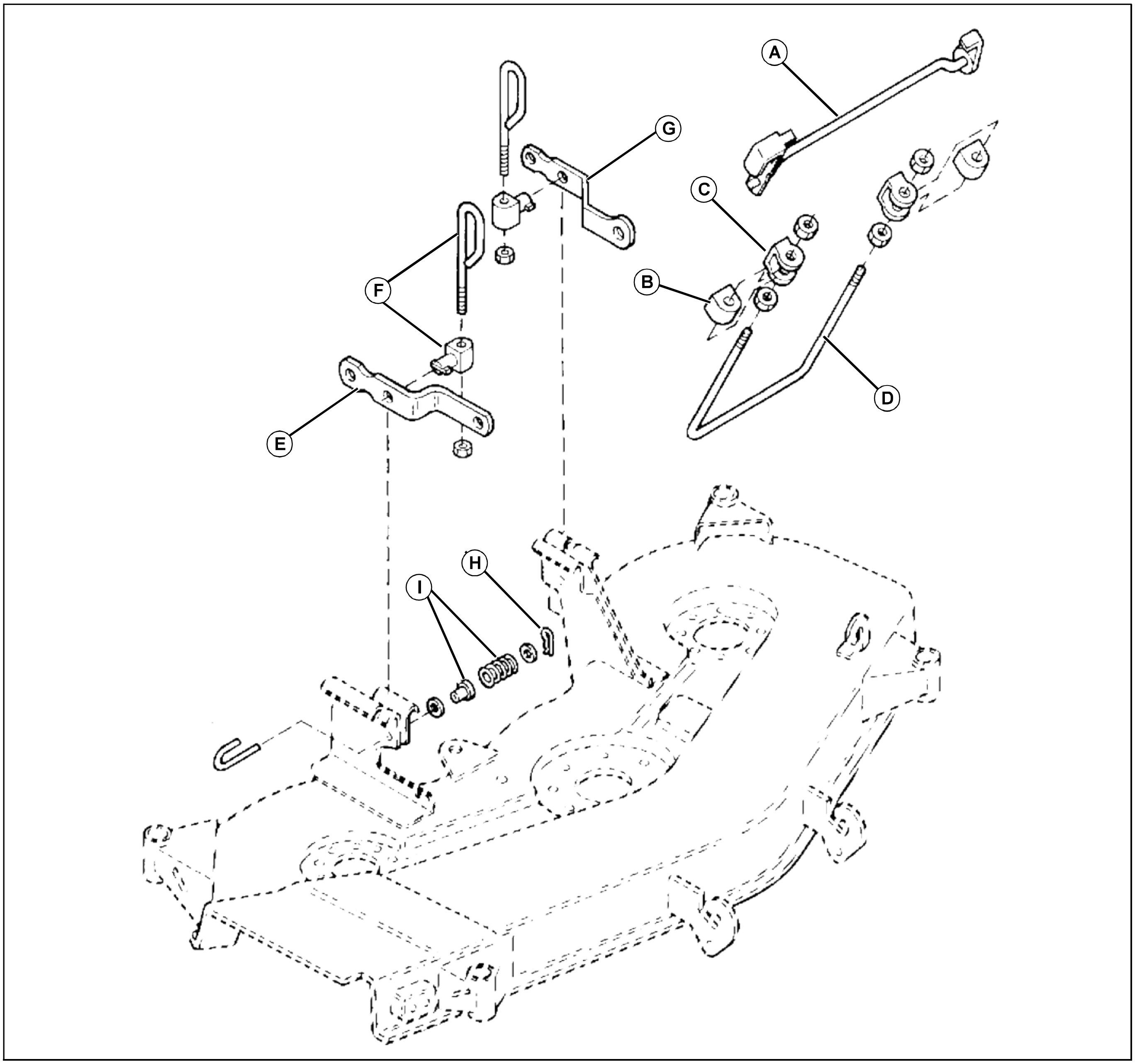
Mower Deck Component Location



MIF

- **A - Greaseable Spindle Access**
- **B - Right Rear Gauge Wheel**
- **C - Secondary Drive Belt**
- **D - Jack Sheave Assembly**
- **E - Primary Belt Tensioning Rod**
- **F - Primary Belt Tensioning Spring**
- **G - Rear Draft Arm Attaching Bracket**
- **H - J-Pin Assembly**
- **I - Fixed Secondary Belt Idler Sheave**
- **J - Left Rear Gauge Wheel Assembly**
- **K - Blade**
- **L - Quick-Release Belt Tensioning Handle**
- **M - Left Front Gauge Wheel**
- **N - Secondary Drive Belt Idler Tensioning Spring**
- **O - Front Draft Arm Hangers**
- **P - Primary Drive Belt**
- **Q - Secondary Drive Belt Idler Sheave**
- **R - Left Front Gauge Wheel**
- **S - Hinge Assembly**
- **T - Discharge Chute**

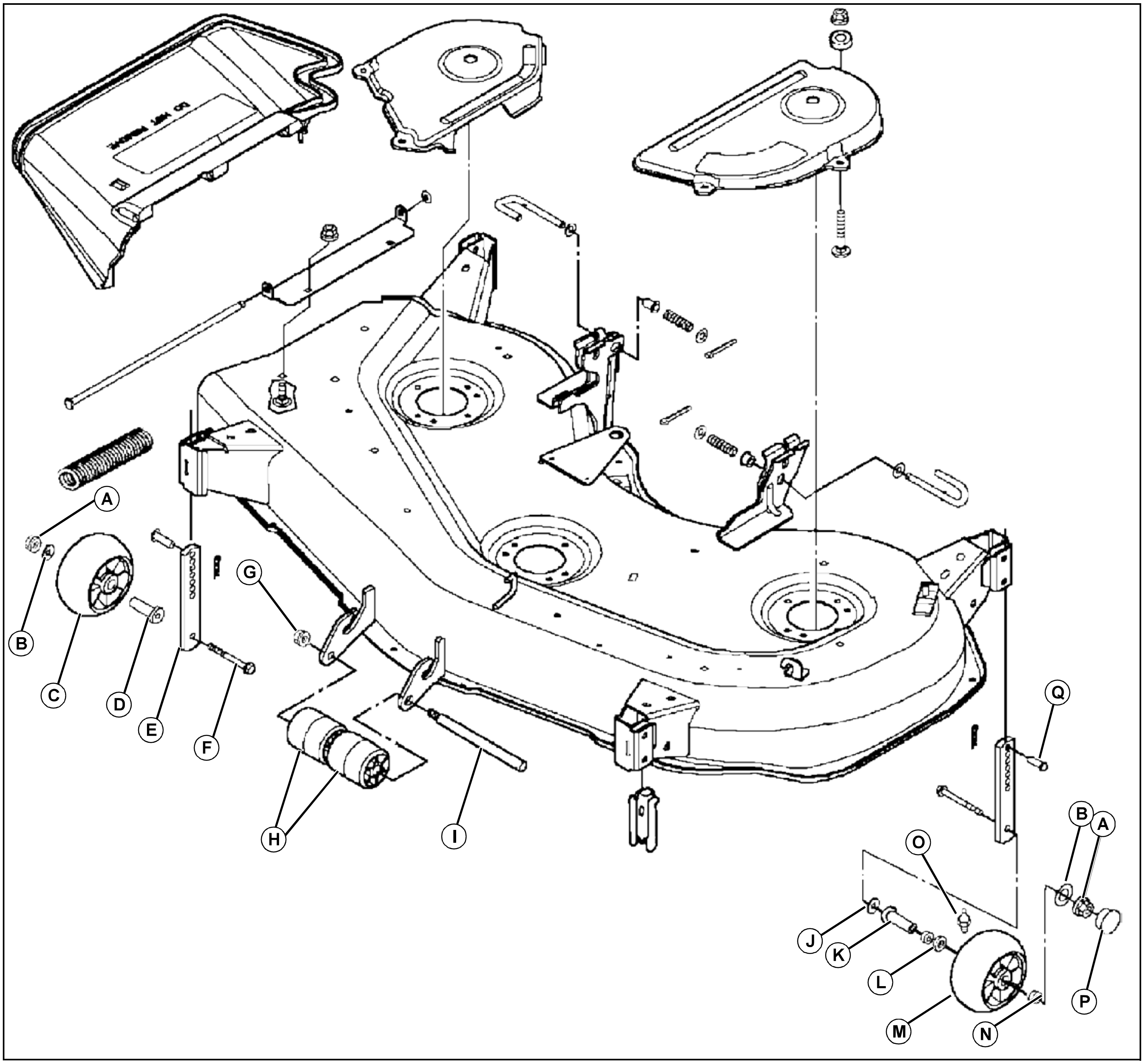
Draft Arms



M80845

A - Pivot
B - Spacer (2 used)
C - Clevis (2 used)
D - Front Draft Rod
E - Rear Draft Arm (Right)
F - Lift Link Assembly (2 used)
G - Rear Draft Arm (Left)
H - Cotter Pin (2 used)
I - J-Pin Assembly (2 used)

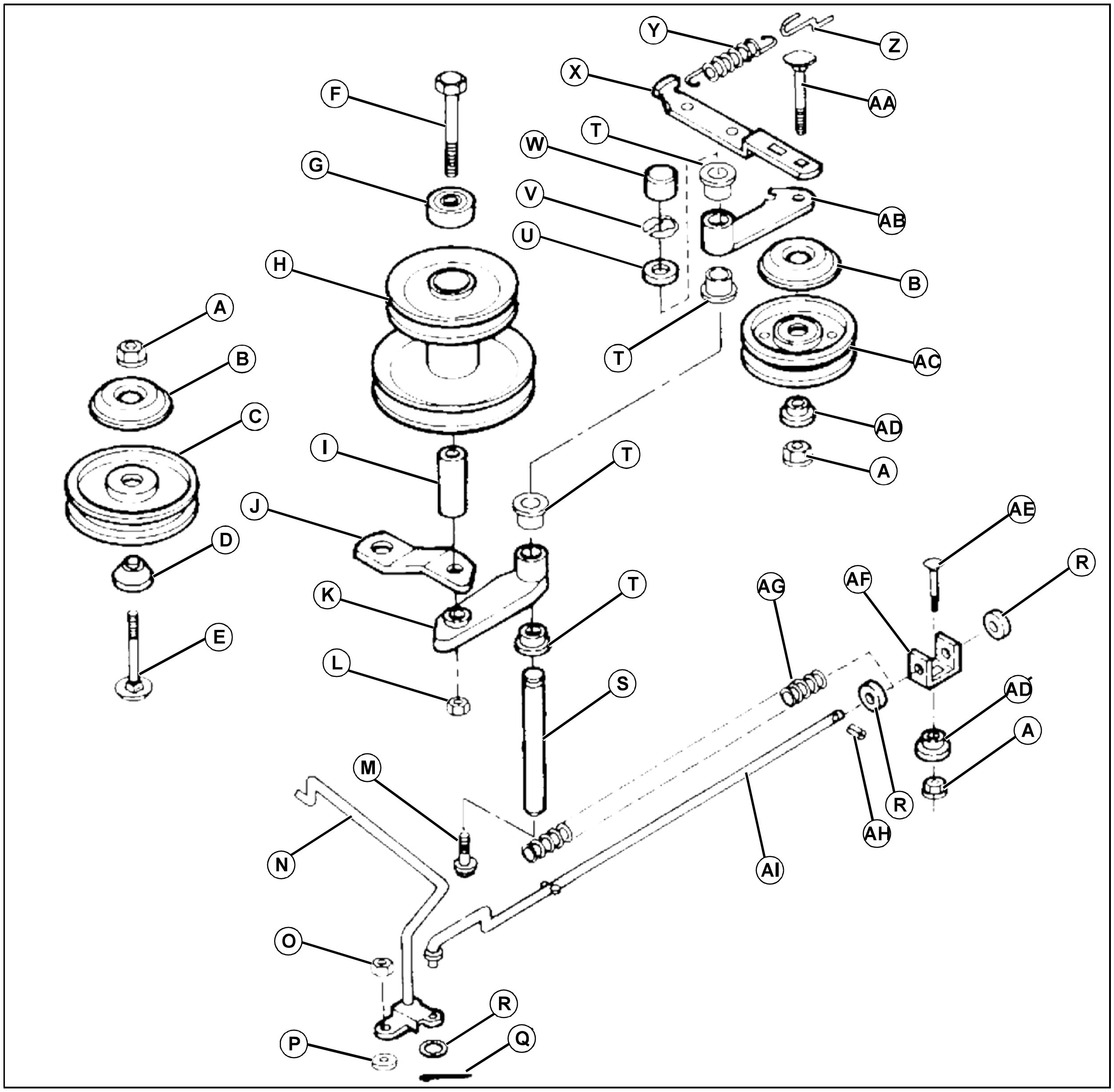
Gauge Wheels



M95458

- A - Flange Nut (4 used)
- B - Washer (4 used)
- C - Front Gauge Wheel (2 used)
- D - Bushing (2 used)
- E - Gauge Wheel Bar (4 used)
- F - Carriage Bolt
- G - Nut
- H - Front Rollers
- I - Roller Shaft
- J - Washer
- K - Bushing (2 used)
- L - Lock Washer
- M - Rear Gauge Wheel (2 used)
- N - Bushing
- O - Grease Fitting
- P - Cap
- Q - Pin (4 used)

Jacksheave and Idlers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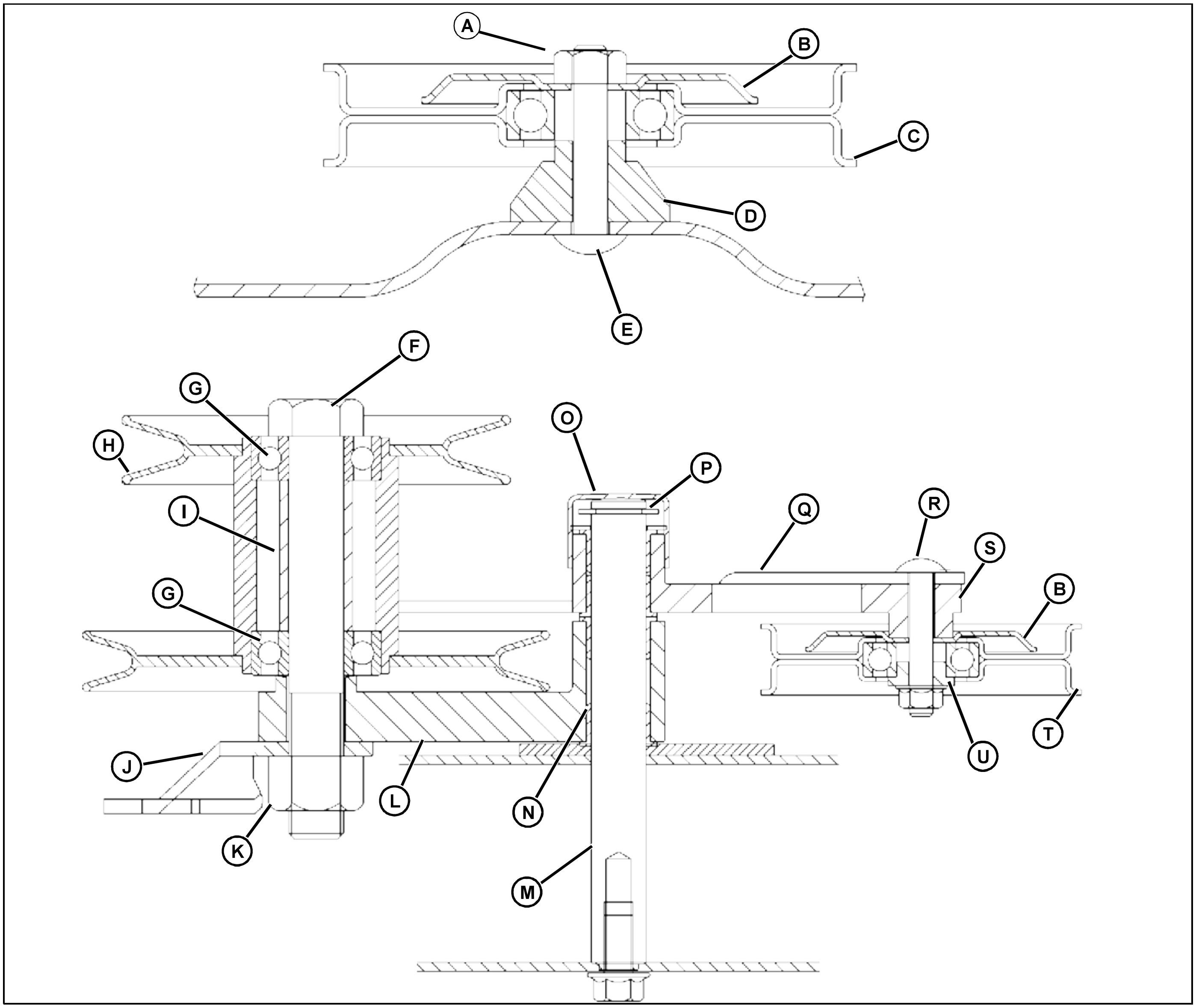
M82803A

- A - Nut
- B - Shield
- C - Fixed Idler Sheave
- D - Spacer
- E - Carriage Bolt
- F - Cap Screw
- G - Ball Bearing (2 used)
- H - Jack Sheave
- I - Spacer
- J - Jack Sheave Tensioning Arm
- K - Jack Sheave Arm
- L - Nut
- M - Cap Screw
- N - Tensioner Handle
- O - Nut
- P - Washer
- Q - Cotter Pin
- R - Washer
- S - Shaft
- T - Bushing
- U - Washer
- V - E-Ring
- W - Cap
- X - Secondary Spring Arm
- Y - Spring
- Z - Hook (Welded)
- AA- Carriage Bolt

AB- Secondary Idler Arm
AC- Tensioning Idler Sheave
AD- Bushing
AE- Carriage Bolt
AF- Bracket
AG- Primary Belt Tensioning Spring
AH- Spring Pin
AI - Tensioner Rod

Jack Sheave and Idlers - Cross Section



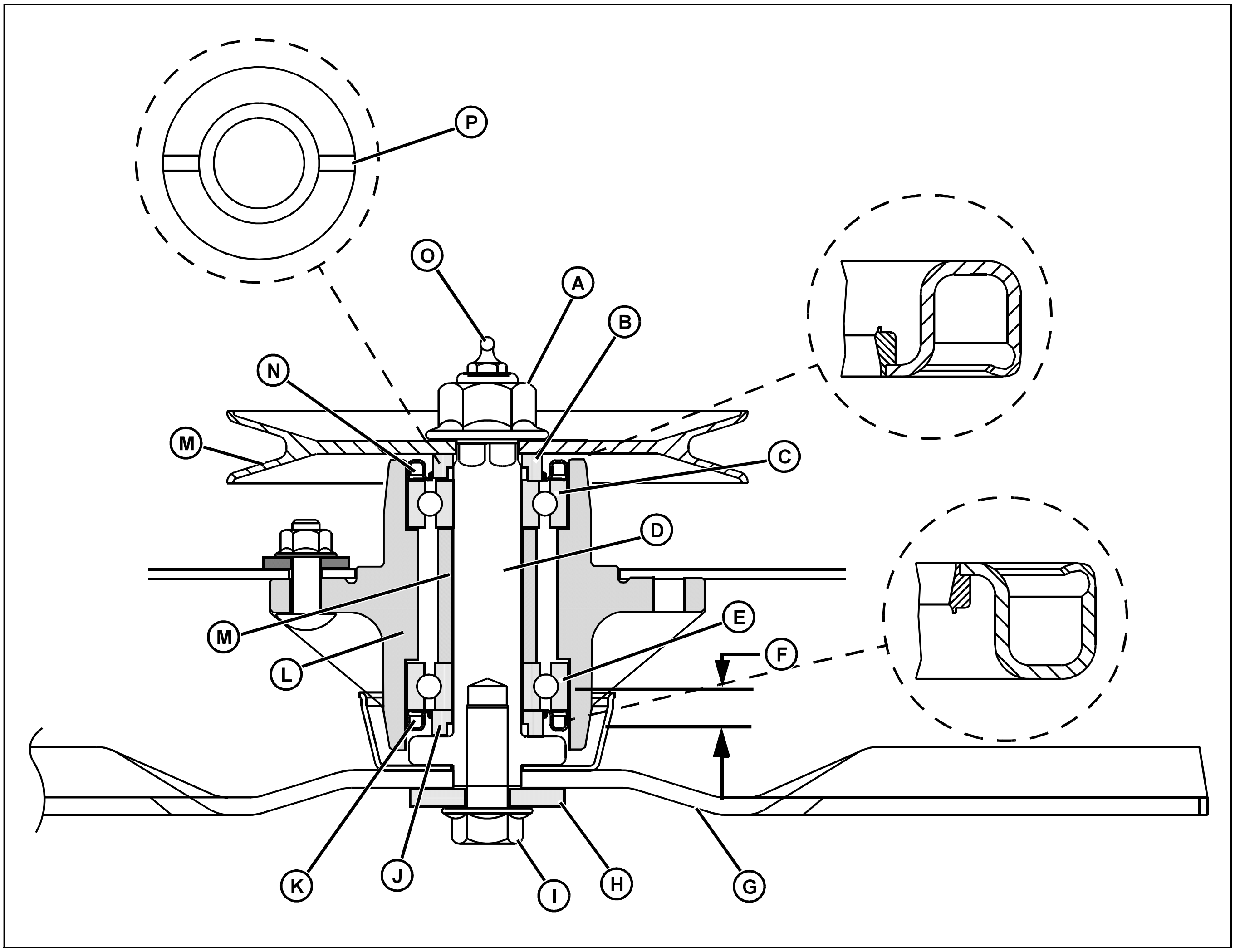
M99538

A - Nut
B - Shield
C - Fixed Idler Sheave
D - Spacer
E - Carriage Bolt
F - Cap Screw
G - Ball Bearing (2 used)
H - Jack Sheave
I - Spacer
J - Jack Sheave Tensioning Arm
K - Nut
L - Jack Sheave Arm
M - Shaft
N - Bushing
O - Cap
P - E-Ring
Q - Secondary Spring Arm
R - Carriage Bolt
S - Secondary Idler Arm

T - **Tensioning Idler Sheave**

U - **Bushing**

Spindle - Cross Section



MIF

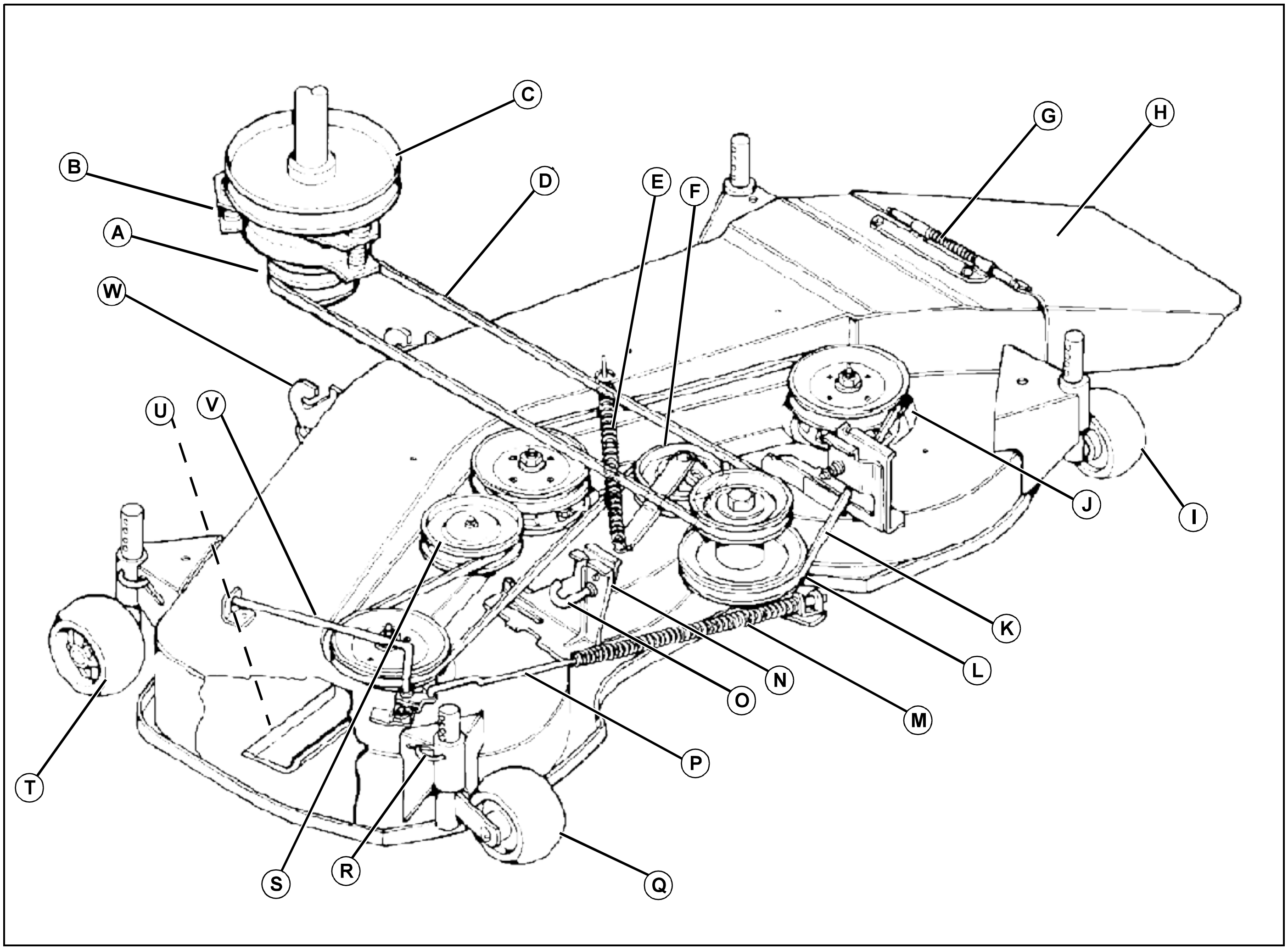
Q - **Grease Notch**

A - **Nut**
B - **Upper Seal Ring**
C - **Upper Bearing**
D - **Spindle Shaft**
E - **Lower Bearing**
F - **Seal Depth - 7.3 mm (0.29 in.)**
G - **Blade**
H - **Blade Washer**
I - **Cap Screw**
J - **Lower Seal Ring**
K - **Lower Seal**
L - **Spindle Housing**
M - **Spacer**
N - **Spindle Sheave**
O - **Upper Seal**
P - **Lubrication Fitting**

NOTE: Upper seal ring (B) is installed with grease notch (Q) facing toward upper bearing (C).

54-Inch Mower Deck

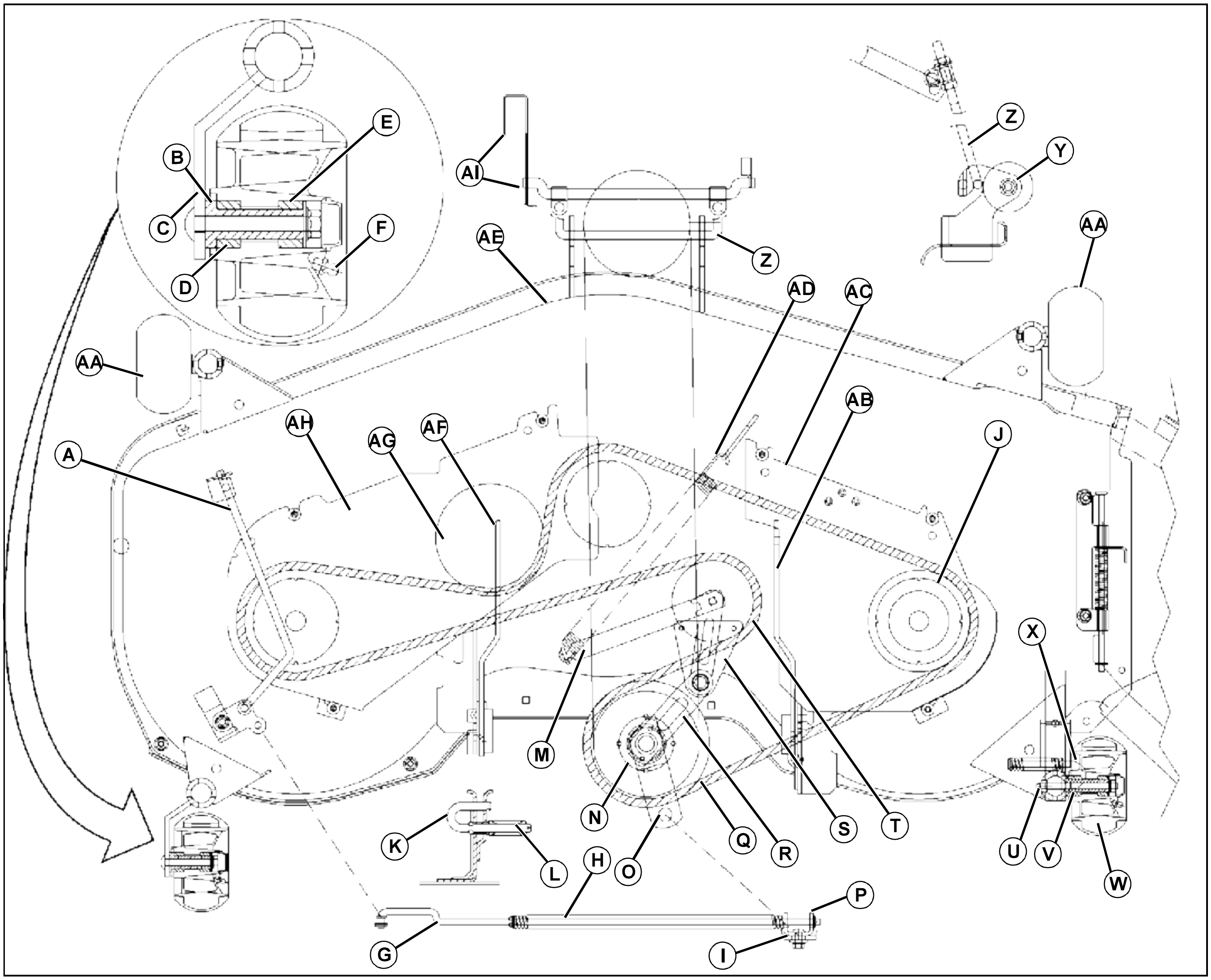
Component View



M45782

A - PTO Drive Sheave
B - PTO Clutch
C - Traction Drive Sheave
D - Primary Drive Belt
E - Secondary Drive Belt Idler Tensioning Spring
F - Secondary Drive Belt Idler Sheave
G - Hinge Assembly
H - Discharge Chute
I - Right Rear Gauge Wheel
J - Greaseable Spindles
K - Secondary Drive Belt
L - Jack Sheave Assembly
M - Primary Belt Tensioning Spring
N - Rear Draft Arm Attaching Bracket
O - J-Pin Assembly
P - Primary Belt Tensioning Rod
Q - Left Rear Gauge Wheel Assembly
R - J-Pin Assembly
S - Fixed Secondary Belt Idler Sheave
T - Left Front Gauge Wheel
U - Blade
V - Quick-Release Belt Tensioning Handle
W - Front Draft Arm Hangers

Overall View



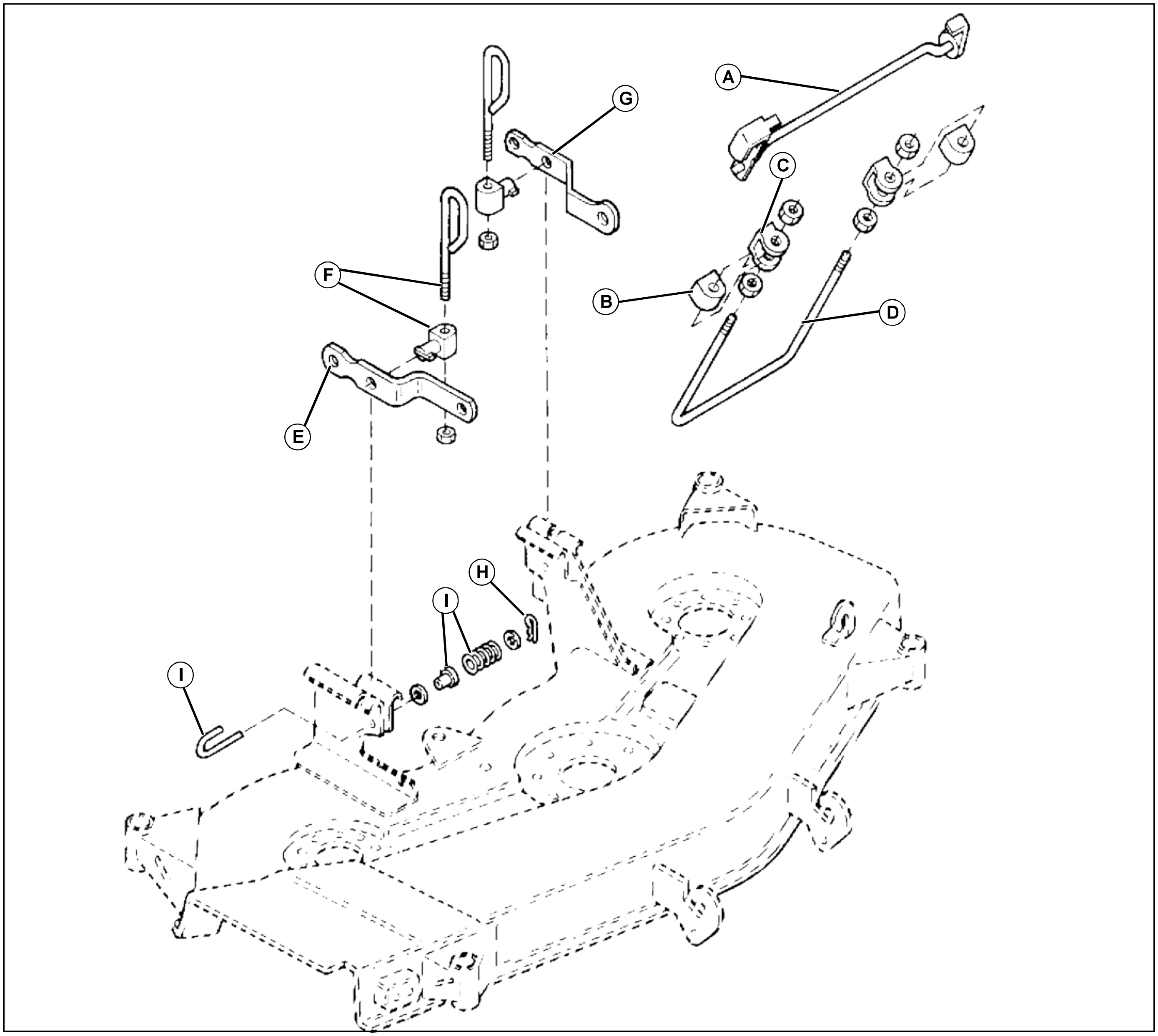
M99523

A - Quick Release Belt Tensioning Handle
B - Bushing
C - Gauge Wheel Arm
D - Seal
E - Bushing
F - Grease Fitting
G - Primary Belt Tensioning Rod
H - Primary Belt Tensioning Spring
I - Bushing
J - Spindle (3 used)
K - J-Pin Assembly
L - Spring
M - Tensioning Spring Arm
N - Jack Sheave
O - Jack Sheave Tensioning Arm
P - Clevis
Q - Secondary Drive Belt
R - Jack Sheave Arm
S - Secondary Idler Sheave Arm
T - Secondary Drive Belt Idler Sheave
U - Gauge Wheel Shaft (Bolt)
V - Bushing (3 used)
W - Rear Gauge Wheel (2 used)
X - J-Pin Assembly
Y - Front Rollers
Z - Front Draft Rod
AA- Front Gauge Wheel (2 used)
AB- Right Rear Draft Arm
AC- Right Belt Shield
AD- Secondary Drive Belt Idler Tensioning Spring
AE- Primary Drive Belt
AF- Left Rear Draft Arm
AG- Fixed Idler Sheave

AH- Left Belt Shield

AI - Front Draft Rod Pivot

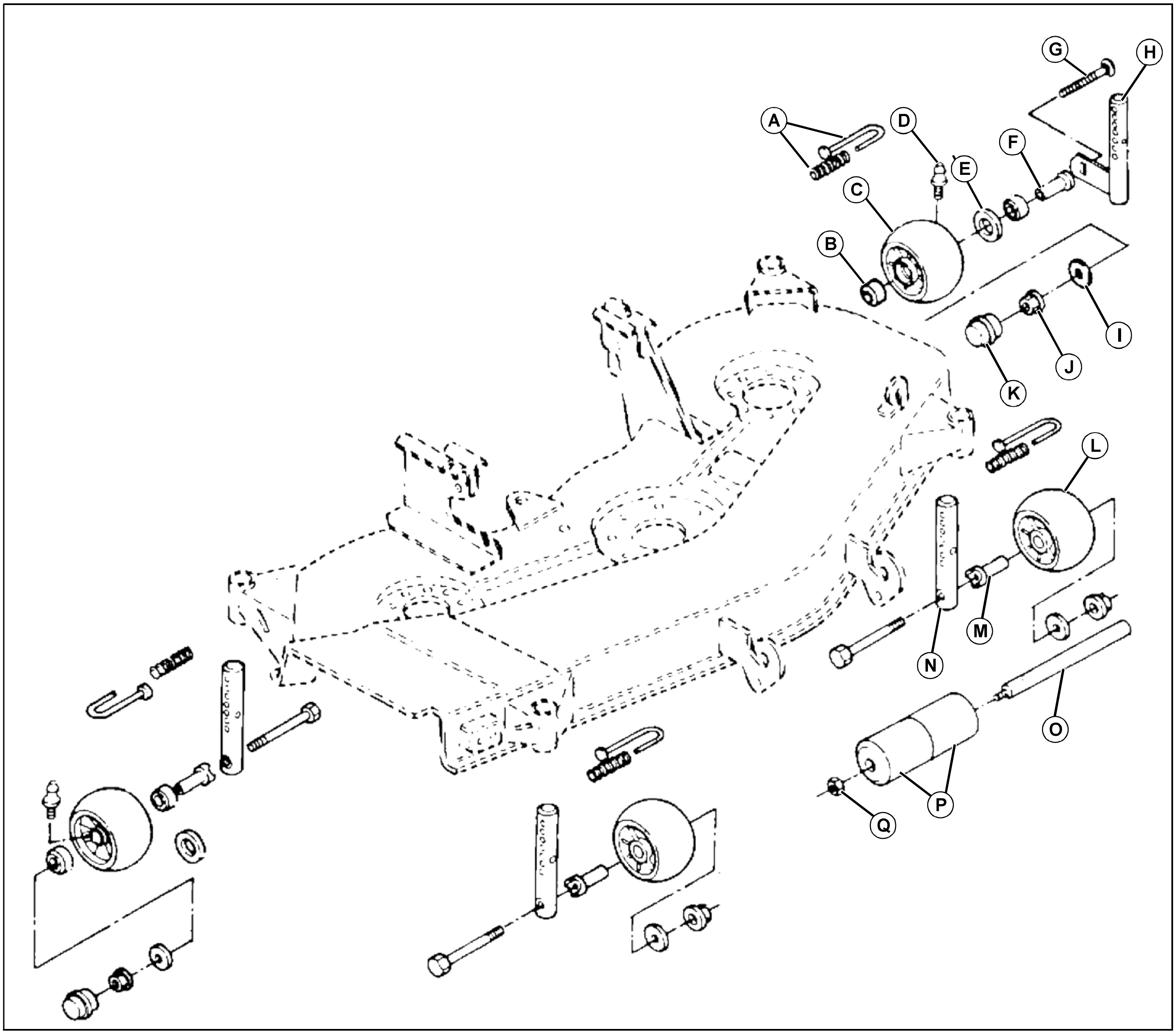
Draft Arms



M80845

A - Pivot
B - Spacer (2 used)
C - Clevis (2 used)
D - Front Draft Rod
E - Rear Draft Arm (Right)
F - Lift Link Assembly (2 used)
G - Rear Draft Arm (Left)
H - Cotter Pin (2 used)
I - J-Pin Assembly (2 used)

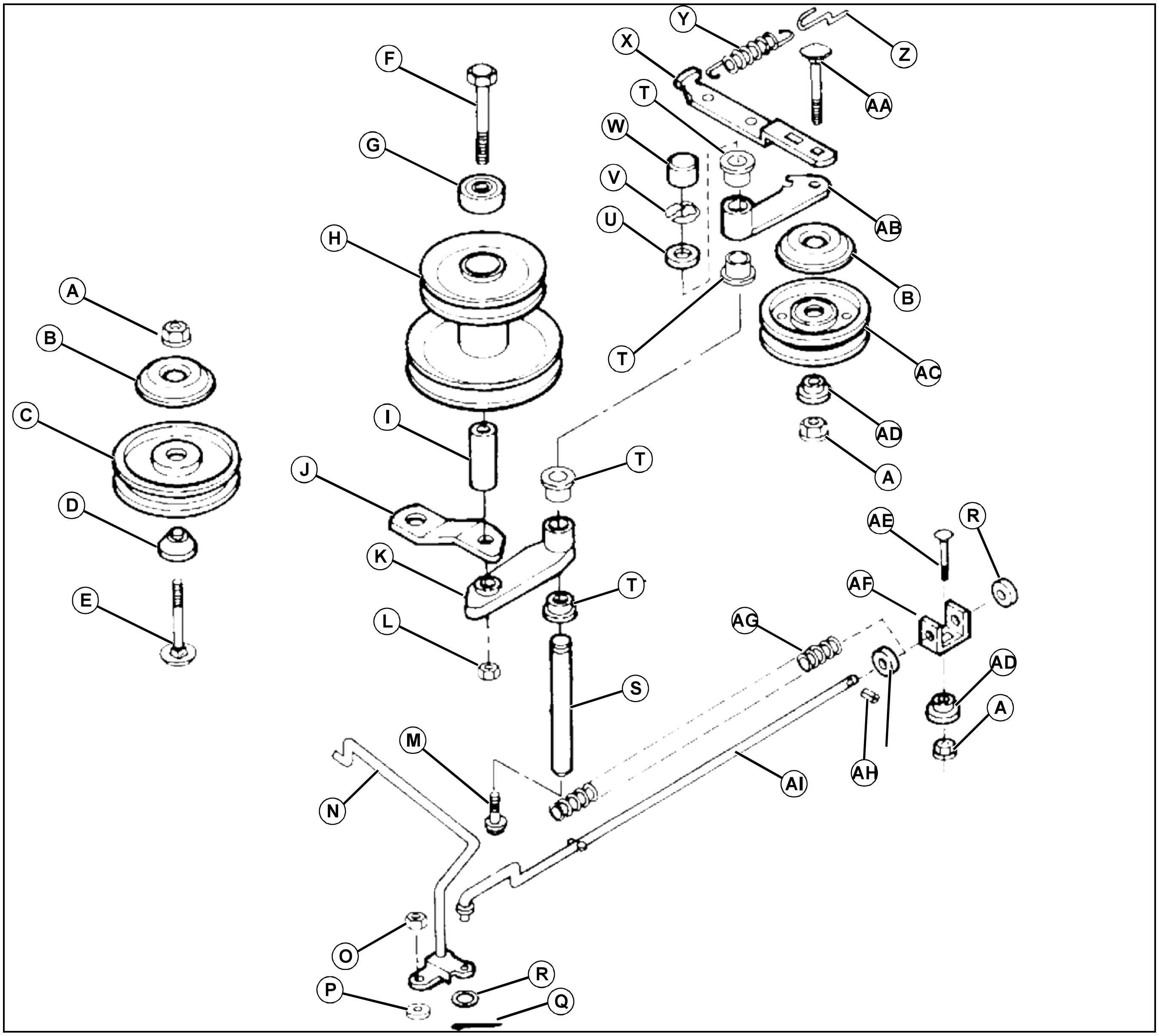
Gauge Wheels



M80846

- A - J-Pin Assembly (4 used)
- B - Bushing (4 used)
- C - Rear Gauge Wheel (2 used)
- D - Grease Fitting (2 used)
- E - Seal (2 used)
- F - Bushing
- G - Carriage Bolt
- H - Gauge Wheel Arm
- I - Washer (4 used)
- J - Flange Nut (4 used)
- K - Cap
- L - Front Gauge Wheel (2 used)
- M - Bushing (3 used)
- N - Gauge Wheel Shaft (3 used)
- O - Roller Shaft
- P - Front Rollers
- Q - Nut

Jack Sheave and Idlers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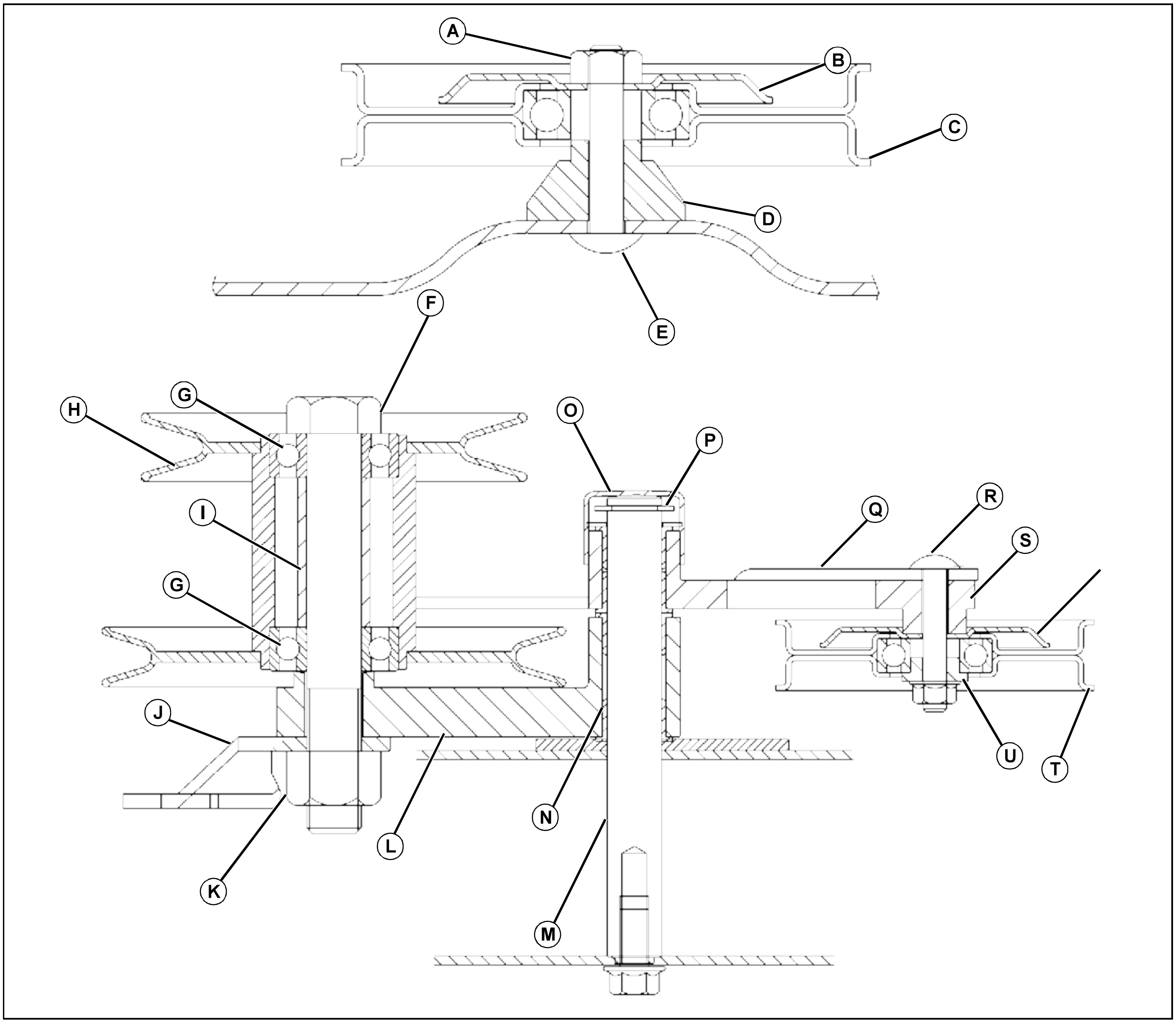
M82803A

- A - Nut
- B - Shield
- C - Fixed Idler Sheave
- D - Spacer
- E - Carriage Bolt
- F - Cap Screw
- G - Ball Bearing (2 used)
- H - Jack Sheave
- I - Spacer
- J - Jack Sheave Tensioning Arm
- K - Jack Sheave Arm
- L - Nut
- M - Cap Screw
- N - Tensioning Handle
- O - Nut
- P - Washer
- Q - Cotter Pin
- R - Washer
- S - Shaft
- T - Bushing
- U - Washer
- V - E-Ring
- W - Cap
- X - Secondary Spring Arm
- Y - Spring
- Z - Hook (Welded)
- AA- Carriage Bolt
- AB- Secondary Idler Arm
- AC- Tensioning Idler Sheave

AD- Bushing
AE- Carriage Bolt
AF- Bracket
AG- Primary Belt Tensioning Spring
AH- Spring Pin
AI - Tensioner Rod

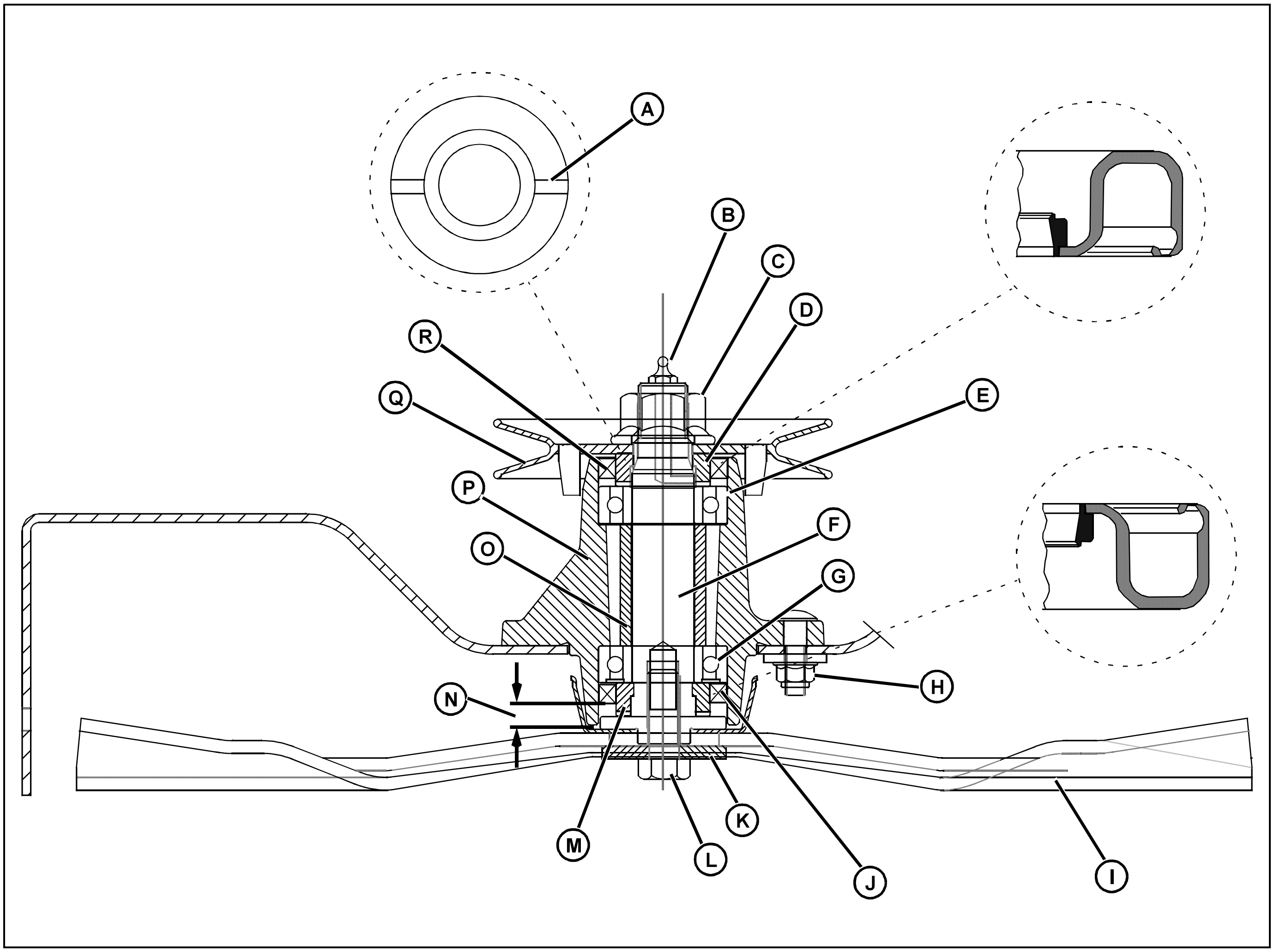
Jack Sheave and Idlers - Cross Section



M99538

A - Nut
B - Shield
C - Fixed Idler Sheave
D - Spacer
E - Carriage Bolt
F - Cap Screw
G - Ball Bearing (2 used)
H - Jack Sheave
I - Spacer
J - Jack Sheave Tensioning Arm
K - Nut
L - Jack Sheave Arm
M - Shaft
N - Bushing
O - Cap
P - E-Ring
Q - Secondary Spring Arm
R - Carriage Bolt
S - Secondary Idler Arm
T - Tensioning Idler Sheave
U - Bushing

Spindle - Cross Section



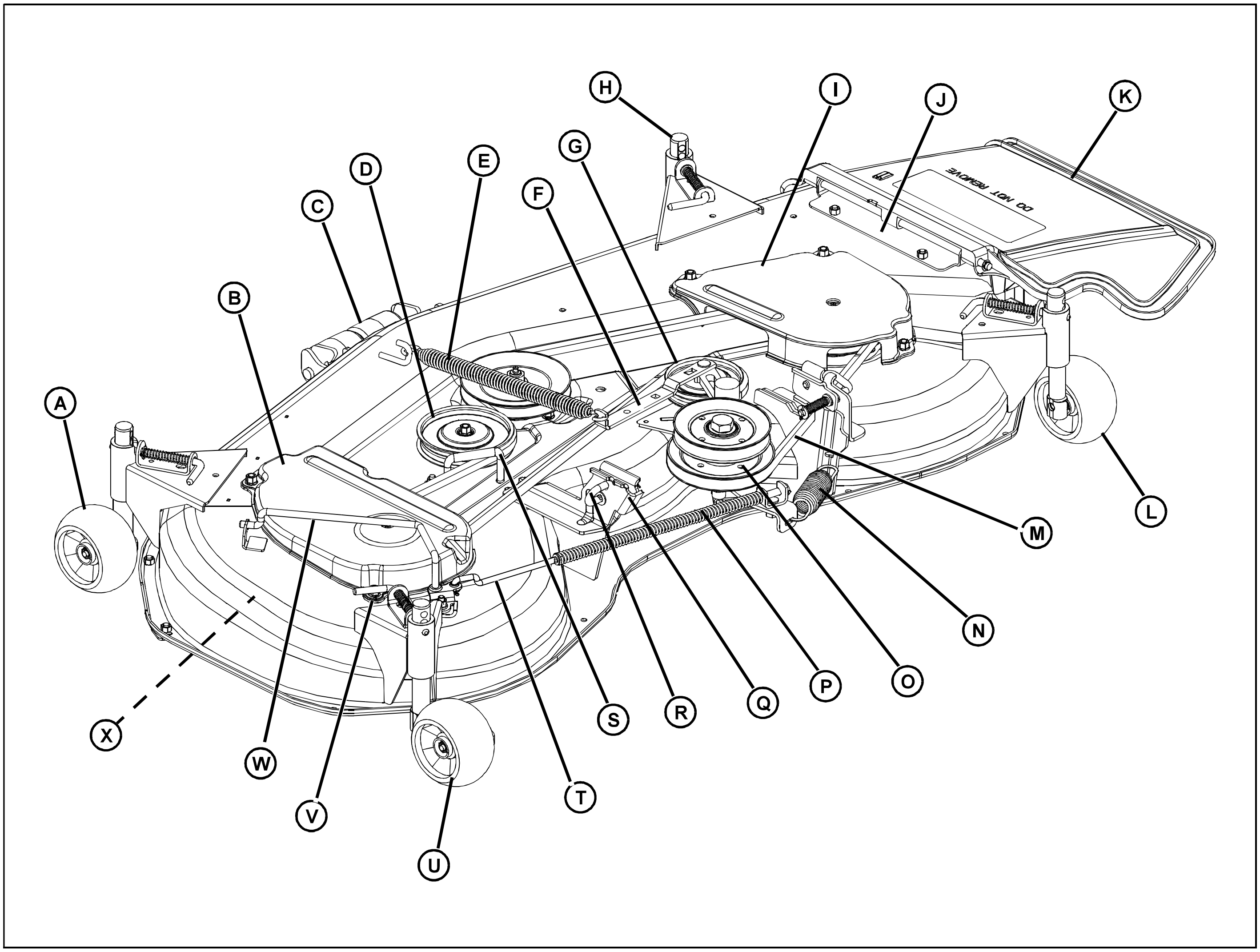
MIF

R - **Upper Seal**

A - **Grease Notch (Upper-Face Towards Bearing and Lower-Face Away From Bearing)**
B - **Lubrication Fitting**
C - **Nut**
D - **Upper Seal Ring**
E - **Upper Bearing**
F - **Spindle Shaft**
G - **Lower Bearing**
H - **Nut (4 used)**
I - **Blade**
J - **Lower Seal**
K - **Washer**
L - **Cap Screw**
M - **Lower Seal Ring**
N - **Seal Depth - 7.3 mm (0.29 in.)**
O - **Spacer**
P - **Hub**
Q - **Spindle Sheave**

54-Inch Convertible Mower Deck

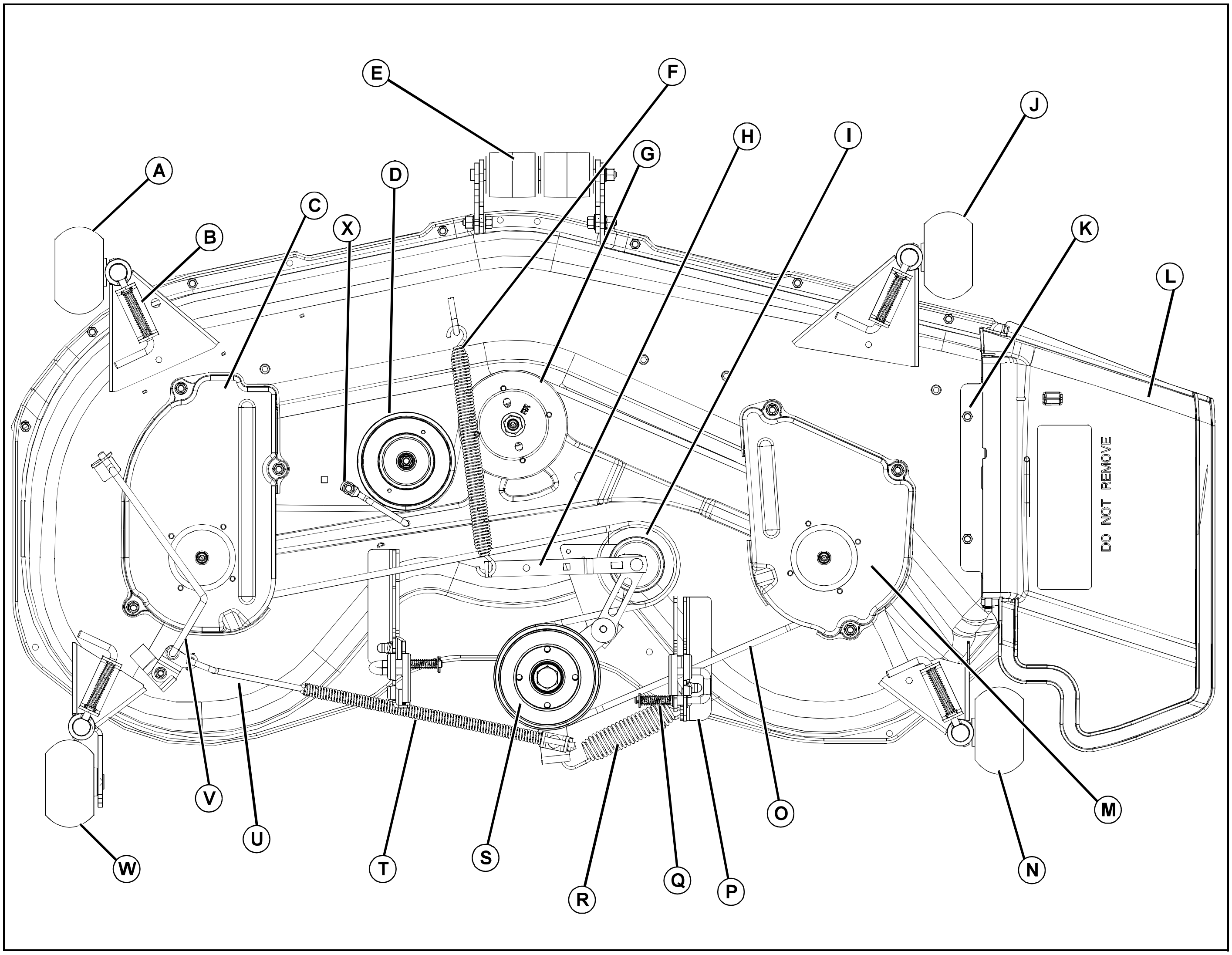
Component View



MIF

- A - Left Front Gauge Wheel
- B - Left Belt Shield
- C - Front Rollers
- D - Fixed Secondary Belt Idler Sheave
- E - Secondary Drive Belt Idler Tensioning Spring
- F - Tensioning Spring Arm
- G - Secondary Drive Belt Idler Sheave
- H - Right Front Gauge Wheel
- I - Right Belt Shield
- J - Hinge Assembly
- K - Discharge Chute
- L - Right Rear Gauge Wheel
- M - Secondary Drive Belt
- N - Spring
- O - Jack Sheave Assembly
- P - Primary Belt Tensioning Spring
- Q - Rear Draft Arm Attaching Bracket
- R - J-Pin Assembly (2 used)
- S - Belt Guide
- T - Primary Belt Tensioning Rod
- U - Left Rear Gauge Wheel
- V - L-Pin Assembly (4 used)
- W - Quick-Release Belt Tensioning Handle
- X - Blade (3 used)

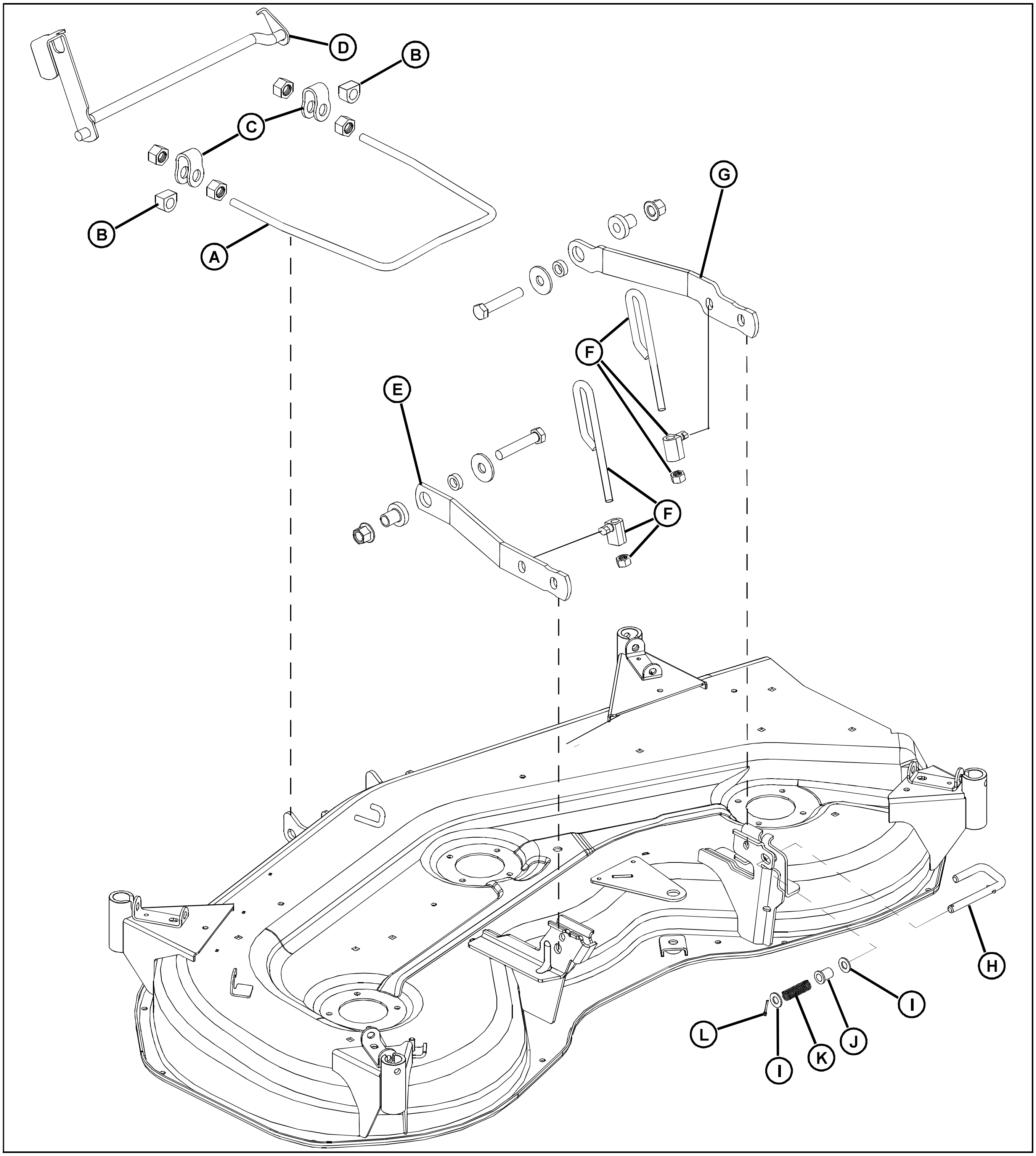
Overall View



MIF

A - Left Front Gauge Wheel
B - L-Pin Assembly (4 used)
C - Left Belt Shield
D - Fixed Idler Sheave
E - Rollers
F - Secondary Drive Belt Idler Tensioning Spring
G - Spindle (3 used)
H - Tensioning Spring Arm
I - Secondary Drive Belt Idler Sheave
J - Right Front Gauge Wheel
K - Hinge Assembly
L - Discharge Chute
M - Right Belt Shield
N - Right Rear Gauge Wheel
O - Secondary Drive Belt
P - Rear Draft Arm Attaching Bracket
Q - J-Pin Assembly (2 used)
R - Spring
S - Jack Sheave Assembly
T - Primary Belt Tensioning Spring
U - Primary Belt Tensioning Rod
V - Quick Release Belt Tensioning Handle
W - Left Rear Gauge Wheel
X - Belt Guide

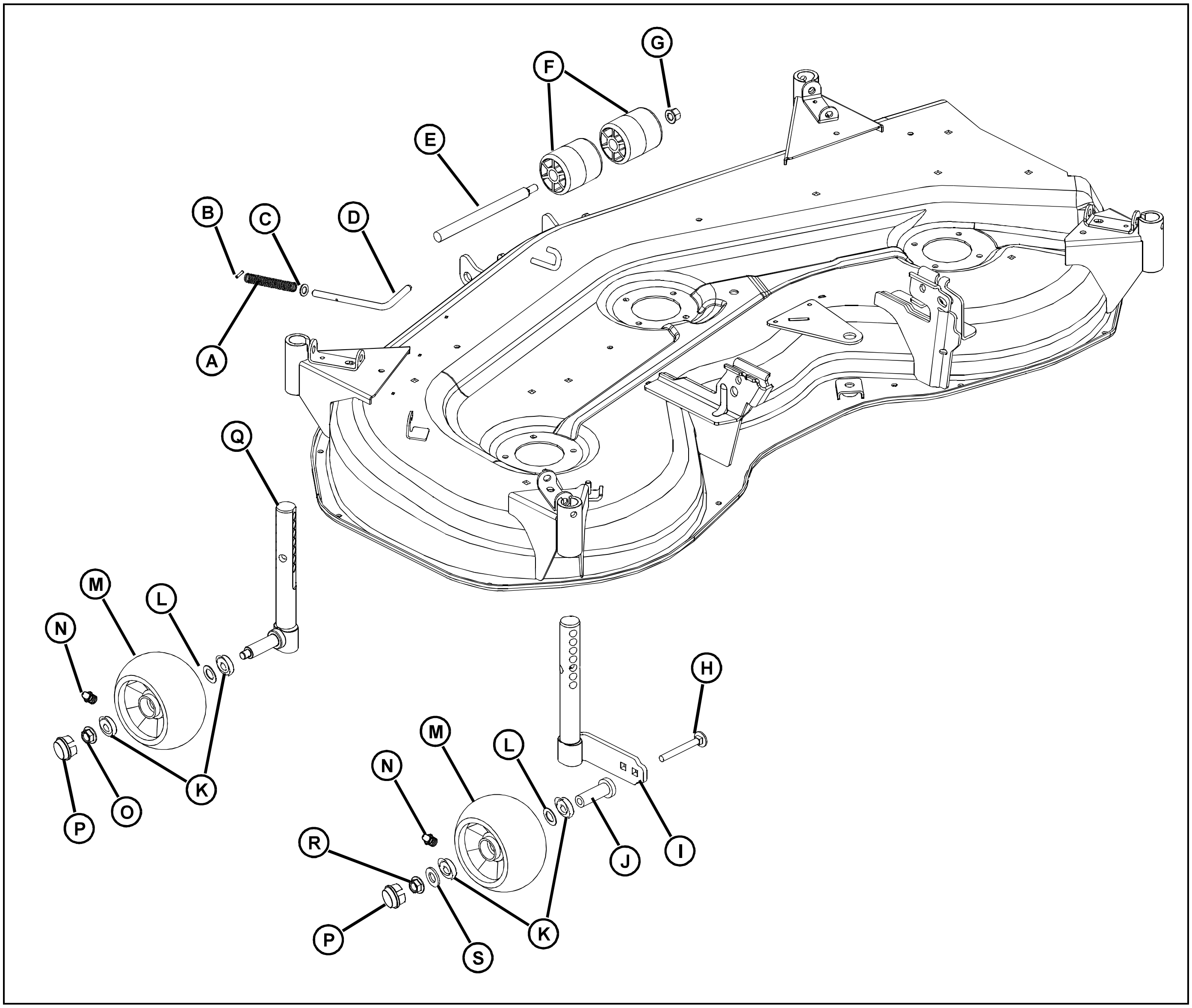
Draft Arms



MIF

A - Front Draft Rod
B - Spacer (2 used)
C - Clevis (2 used)
D - Pivot
E - Rear Draft Arm (Left)
F - Lift Link Assembly (2 used)
G - Rear Draft Arm (Right)
H - J-Pin
I - Washer (2 used)
J - Bushing
K - Spring
L - Cotter Pin

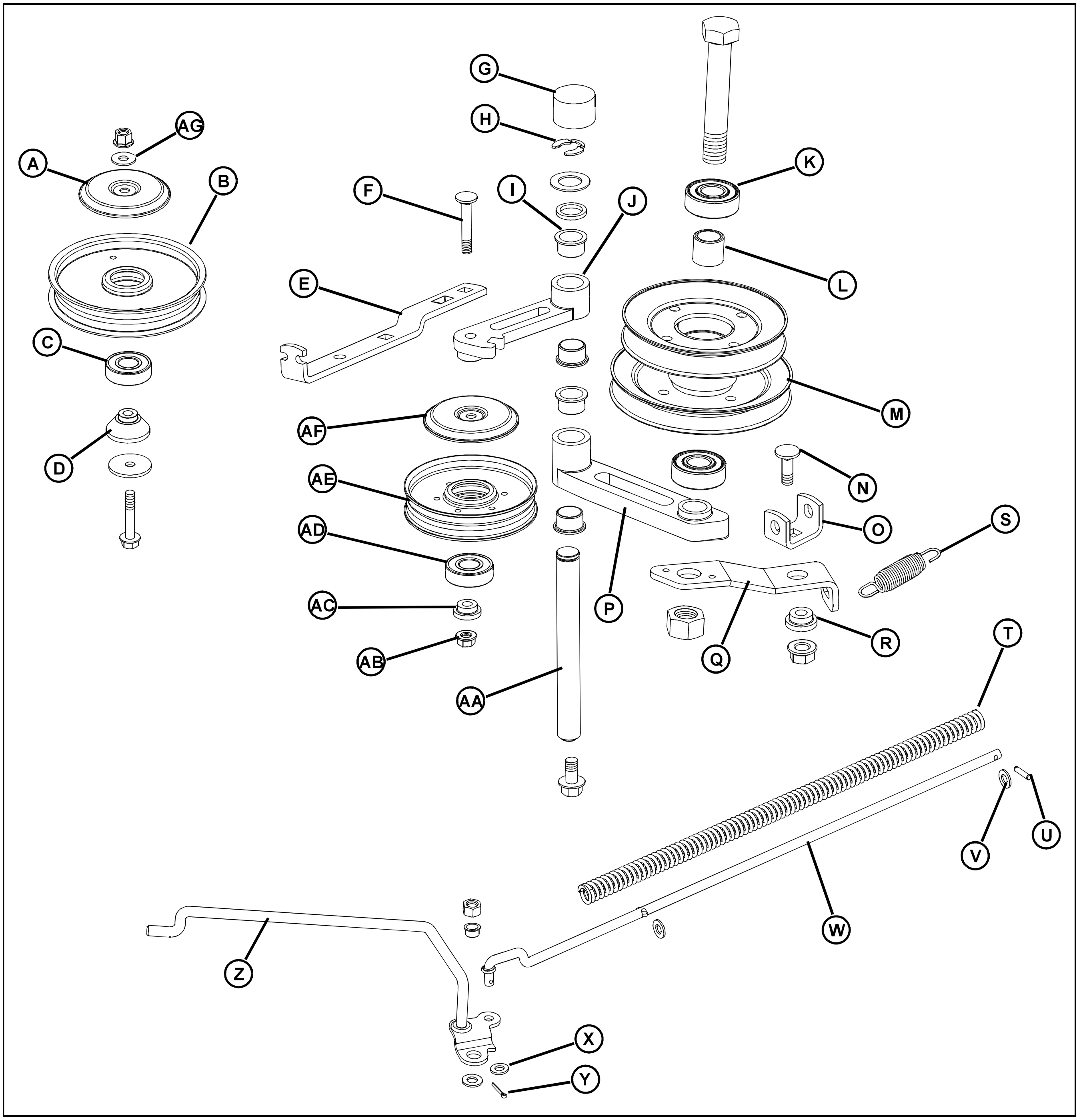
Gauge Wheel



MIF

- A - J-Pin Spring
- B - Pin
- C - Washer
- D - Adjuster Pin (4 used)
- E - Roller Shaft
- F - Front Rollers (2 used)
- G - Flange Nut
- H - Carriage Bolt
- I - Gauge Wheel Arm (Rear)
- J - Bushing (Flat)
- K - Bushing (2 per wheel)
- L - Seal
- M - Gauge Wheel
- N - Grease Fitting
- O - Flange Nut (M10)
- P - Cap
- Q - Gauge Wheel Arm (Front)
- R - Flange Nut (M8)
- S - Washer

Jack Sheave and Idlers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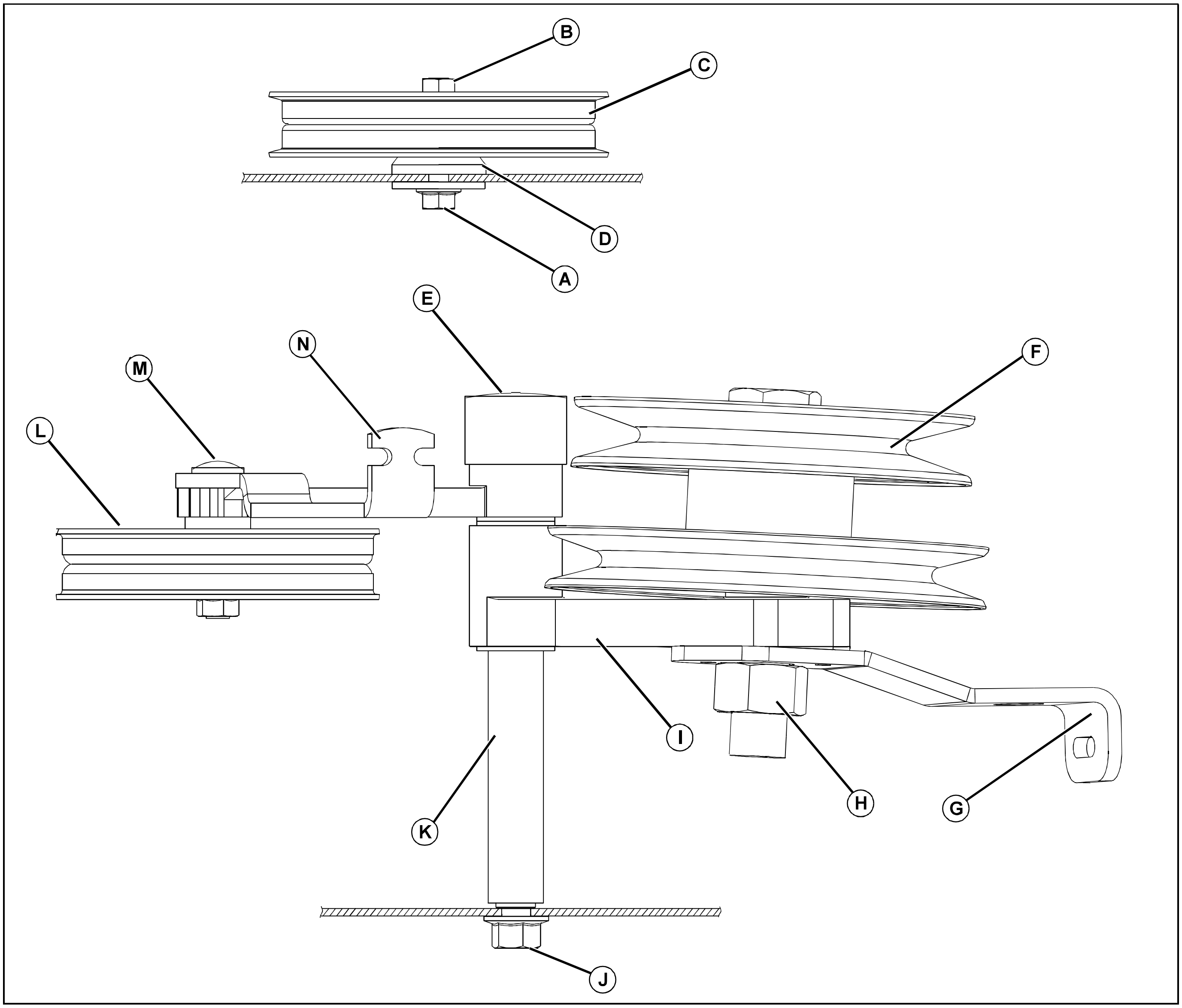
MIF

A - Shield
B - Fixed Idler Sheave
C - Bearing
D - Spacer
E - Tensioning Spring Arm (Secondary)
F - Carriage Bolt
G - Plug
H - Snap Ring
I - Bushing (4 used)
J - Tensioning Idler Sheave Arm (Secondary)
K - Ball Bearing (2 used)
L - Spacer
M - Jack Sheave
N - Carriage Bolt
O - Clevis
P - Jack Sheave Arm
Q - Tensioning Arm
R - Bushing
S - Spring

T - Belt Tensioning Spring
U - Cotter Pin
V - Washer (2 used)
W - Primary Belt Tensioning Rod
X - Washer
Y - Cotter Pin
Z - Quick Release Belt Tensioning Handle

AA- Shaft
AB- Nut
AC- Bushing
AD- Bearing
AE- Tensioning Idler Sheave
AF- Shield
AG- Washer

Jack Sheave and Idlers - Cross Section

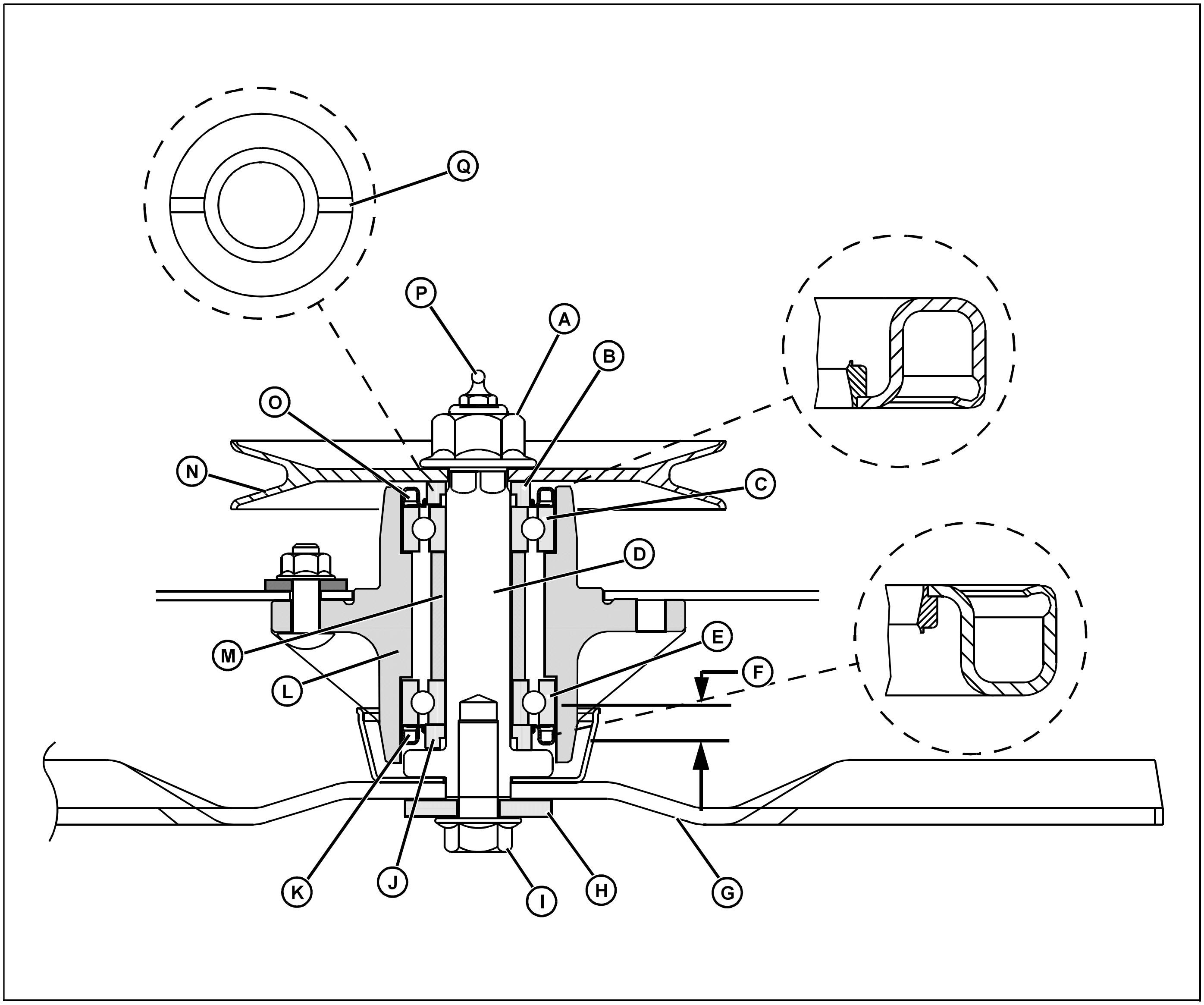


MIF

A - Bolt
B - Nut
C - Fixed Idler Sheave
D - Spacer
E - Cap
F - Jack Sheave

G - Jack Sheave Tensioning Arm
H - Nut
I - Jack Sheave Arm
J - Bolt
K - Shaft
L - Tensioning Idler Sheave
M - Carriage Bolt
N - Secondary Tensioning Idler Sheave Arm

Spindle - Cross Section



MIF

- **A - Nut**
- **B - Upper Seal Ring**
- **C - Upper Bearing**
- **D - Spindle Shaft**
- **E - Lower Bearing**
- **F - Seal Depth - 7.3 mm (0.29 in.)**
- **G - Blade**
- **H - Blade Washer**
- **I - Cap Screw**
- **J - Lower Seal Ring**
- **K - Lower Seal**
- **L - Spindle Housing**
- **M - Spacer**
- **N - Spindle Sheave**
- **O - Upper Seal**
- **P - Lubrication Fitting**
- **Q - Grease Notch**

Diagnostics

Mower Decks Troubleshooting Chart

Symptom: Mower blades don't run

(1) Is the PTO clutch engaged?

No - Engage.

Yes - Go to next step.

(2) Is the primary drive belt broken, worn, frayed, glazed, or stretched?

Yes - Replace belt. See individual belt replacement within this manual.

No - Go to next step.

(3) Is the secondary drive belt broken, worn, frayed, glazed, or stretched?

Yes - Replace belt.

No - Go to next step.

(4) Is the primary belt Quick-Release belt tensioning handle locked in place?

No - Lock in place.

Yes - Go to next step.

(5) Is the secondary drive belt tensioning spring weak or unhooked?

Yes - Replace or reattach spring.

Symptom: Mower deck vibrates

(1) Are blades out of balance?

Yes - See Mower Deck Blades in your manual.

No - Go to next step.

(2) Are blades bent?

Yes - See Mower Deck Blades in your manual.

No - Go to next step.

(3) Are drive sheaves damaged?

Yes - See Jack Sheave in your manual.

Symptom: Deck cut unevenly or with striping

(1) Are blades bent?

Yes - See Mower Deck Blades in your manual.

No - Go to next step.

(2) Is blade level side-to-side out of adjustment?

Yes - See Mower Level Side-to-Side.

Symptom: Deck cut unevenly or with striping

No - Go to next step.

(3) Is blade level front-to-back out of adjustment?

Yes - See Mower Lever Front-to-Rear.

No - Go to next step.

(4) Are blades dull?

Yes - See Mower Deck Blades.

No - Go to next step.

(5) Are gauge wheels adjusted correctly?

No - Adjust wheels.

Yes - Go to next step.

(6) Are drive sheaves damaged?

Yes - See Jack Sheave..

Symptom: Belt Slips

(1) Is the primary drive belt broken, worn, frayed, glazed, or stretched?

Yes - Replace belt.

No - Go to next step.

(2) Is the secondary drive belt broken, worn, frayed, glazed, or stretched?

Yes - Replace belt.

No - Go to next step.

(3) Is the primary belt Quick-Release belt tensioning handle locked in place?

No - Lock handle in place.

Yes - Go to next step.

(4) Is the secondary drive belt tensioning spring weak or unhooked?

Yes - Replace or reattach spring.

No - Go to next step.

(5) Are drive sheaves damaged?

Yes - See Jack Sheave.

Symptom: Belt jumps off sheaves.

(1) Is the primary drive belt broken, worn, frayed, glazed, or stretched?

Yes - Replace belt.

No - Go to next step.

Symptom: Belt jumps off sheaves.

(2) Is the secondary drive belt broken, worn, frayed, glazed, or stretched?

Yes - Replace belt.

No - Go to next step.

(3) Is the primary belt Quick-Release belt tensioning handle locked in place?

No - Lock handle in place.

Yes - Go to next step.

(4) Is the secondary drive belt tensioning spring weak or unhooked?

Yes - Replace or reattach spring.

No - Go to next step.

(5) Are drive sheaves damaged?

Yes - See Jack Sheave.

Mower Drive Checks

Test Conditions:

- Machine parked on a level surface.
- PTO disengaged.
- Parking brake locked.
- Key switch in OFF position.

System: PTO clutch and drive sheave

(1) Is PTO clutch and drive shave tight on crankshaft? (Key not damaged or missing?

Yes - Go to next step.

No - Tighten cap screw. (Replace key, if necessary.)

(2) Is air gap properly adjusted?

Yes - Go to next step.

No - Repair and adjust as needed.

(3) Is belt on sheave?

Yes - Go to next step.

No - Install.

(4) Is sheave binding, damaged or worn?

No - Go to next step.

Yes - Replace sheave.

(5) Does sheave angle match belt angle?

No - Check jack sheave and PTO sheave.

System: Primary drive belt.

(1) Is primary drive belt damaged, worn, broken or turned over?

Yes - Replace.

System: Jack sheave

(1) Is belt on sheave?

Yes - Go to next step.

No - Install.

(2) Is sheave binding, damaged or worn?

No - Go to next step.

Yes - Replace sheave and bearing.

(3) Does sheave angle match belt angle?

Yes - Go to next step.

No - Check jack sheave and PTO sheave.

(4) Is nut at correct torque?

No - Tighten.

System: Primary belt tension spring and rod

(1) Is primary belt tension spring or rod damaged, worn or weak?

Yes - Replace spring or rod.

No - Go to next step.

(2) Is belt tensioning handle in tension position?

No - Move to tension position.

System: Jack sheave arm

(1) Is jack sheave arm binding, damaged or worn?

Yes - Replace jack sheave arm.

System: Secondary drive belt

(1) Is secondary drive belt damaged, worn, broken or turned over?

Yes - Replace belt.

System: Secondary drive belt tensioning spring

(1) Is secondary drive belt tensioning spring damaged, worn or weak?

Yes - Replace spring.

System: Secondary drive belt idler and pivot arm

(1) Is secondary drive belt idler and pivot arm binding, damaged or worn?

No - Go to next step.

Yes - Replace idler.

(2) Is belt in place?

Yes - Go to next step.

No - Install.

(3) Is pivot arm bent, locating idler parallel to belt?

Yes - Replace pivot arm.

System: Fixed idler - 44, 48 and 54-inch only

(1) Is idler binding, damaged or worn?

No - Go to next step.

Yes - Replace idler.

(2) Is belt in place?

No - Install.

System: Spindle sheave

(1) Is spindle sheave tight on spindle with key in place?

Yes - Go to next step.

No - Tighten nut and install key as needed.

(2) Is spindle sheave damaged, bent or not running straight?

No - Go to next step.

Yes - Repair, or replace as needed.

(3) Is belt on sheave?

Yes - Go to next step.

No - Install.

(4) Does Sheave angle matches belt angle?

No - Replace sheave.

System: Spindle and housing

(1) Have bearings failed?

No - Go to next step.

Yes - Replace as needed.

(2) Blade tight on spindle?

No - Tighten hardware.

System: Blade

(1) Is blade bent, worn or damaged?

No - Go to next step.

Yes - Replace blade.

(2) Is blade sharp and balanced?

Yes - Go to next step.

No - Sharpen and balance.

(3) Is blade level side to side?

Yes - Go to next step.

No - Adjust.

(4) Is blade correctly adjusted front to back?

No - Adjust.

System: Mower deck lift linkage

(1) Is mower deck lift linkage mounting hardware tight, not worn?

Yes - Tighten or replace as needed.

System: Engine

(1) Is engine is running at correct rpm?

No - Adjust engine fast idle and governor.

No - Check engine adjustments and condition.

No - Inform operator that engine should be running at fast idle when mowing.

Tests and Adjustments

Mower Level Side-To-Side

Reason:

To set mower deck for an even side-to-side cut.

Equipment:

- TY15272 Blade Height Gauge

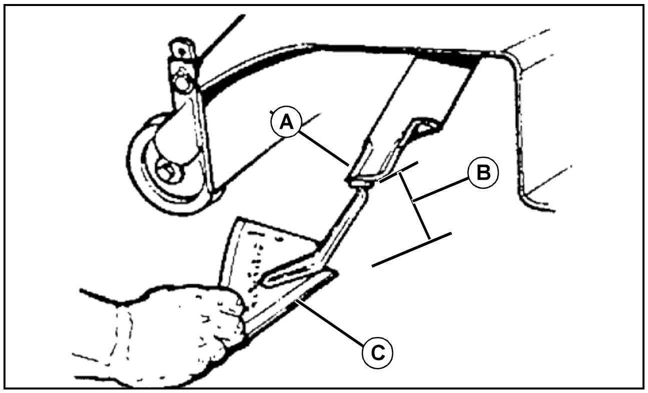
Measurement Procedure:

CAUTION: Avoid injury! ROTATING BLADES/ MOVING PARTS. STOP engine. Remove ignition key. Wait for all moving parts to STOP.

1. Park machine on a hard, level surface.
2. Move forward/reverse pedals to NEUTRAL position. Lock parking brake.
3. Check tires for correct sizes and inflation pressures at all four wheels.
4. Raise gauge wheels to highest setting so they are not on the ground during leveling.
5. Shake deck slightly to ensure deck is settled to lowest point on hangers.

CAUTION: Avoid injury! SHARP EDGES. Wear gloves or wrap blade with a shop towel when handling blades to minimize the risk of personal injury.

6. Rotate blade by hand to check for bent blade or spindle. Repair or replace parts as needed.
7. Set mower cutting height to 63.5 mm (2.5 in.).
8. Rotate mower blades so that tips point toward outside edges of mower deck.



M40161

9. Using a TY15272 Blade Height Gauge (C) or other suitable measuring tool, measure height (B) of outside tips (A) of blade.

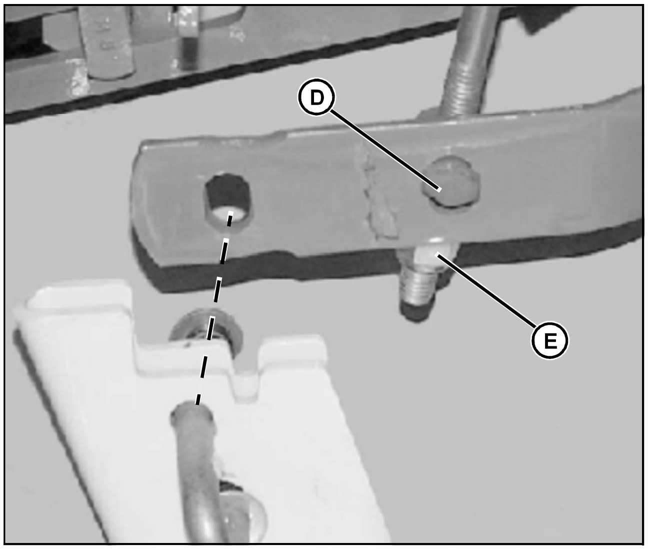
Specifications:

Maximum blade outside tip-to-outside tip height difference. . . . . 3 mm (0.125 in.)

Results:

- If the mower side-to-side height difference is greater than specification, adjust lift link on right side of mower deck.

Adjustment Procedure:



M99566

1. Turn locknut (E) to raise or lower right side of mower deck until blade tip heights are within specification.

NOTE: Adjustable lift links (D) are on both sides of the mower. Cutting height can be made to closely match knob setting by adjusting these lift links.
DO NOT adjust deck too high or it will not lock in the transport (RAISE) position.

2. Turn locknuts (on both sides of mower deck) equally until blade tip heights closely match set mower cutting height.

Mower Level Front-To-Rear

Reason:

To set the mower blade for the best cut and most efficient operation.

Equipment:

- TY15272 Blade Height Gauge

Measurement Procedure:

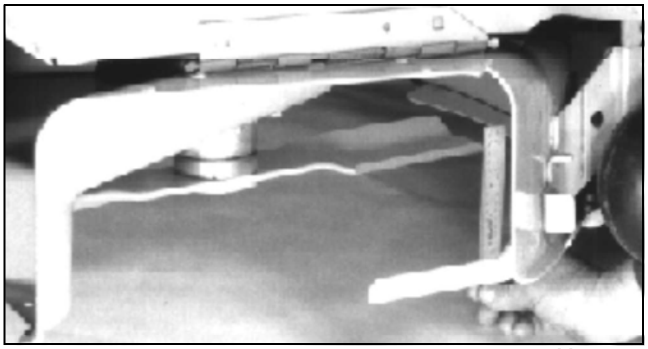
> **CAUTION: Avoid injury! ROTATING BLADES/ MOVING PARTS. STOP engine. Remove ignition key. Wait for all moving parts to STOP.**

1. Park machine on a hard, level surface.
2. Move forward/reverse pedals to NEUTRAL position. Lock parking brake.
3. Check for correct tire sizes and inflation pressures at all four wheels.
4. Raise gauge wheels to highest setting so they are not on the ground during leveling.
5. Shake deck slightly to ensure deck is settled to lowest point on hangers.

> **CAUTION: Avoid injury! SHARP EDGES. Wear gloves or wrap blade with a shop towel when handling blades to minimize the risk of personal injury. DO NOT hold blade with bare hands.**

6. Rotate blade by hand to check for bent blade or spindle. Repair or replace parts as needed.
7. Set mower cutting height to 2.5 in.
8. Rotate mower blades so that the tips point toward the front and rear of the machine.

NOTE: Whenever possible, use same blade tip when verifying measurements and checking front-to-rear deck height.



M39912

9. Using a TY15272 Blade Height Gauge or other suitable measuring tool, measure from front blade tip to ground. Rotate blade by hand 180°, then measure from the rear blade tip to ground. The front tip of the blade should be lower than the rear.
10. Check and adjust the blade height on the opposite side of the mower deck.

Specifications:

38, 44 - Inch Piranha, 48C and 54 - Inch Mowers
Front-to-Rear Blade
Height Difference . . . . 6 - 9 mm (0.250 - 0.375 in.)

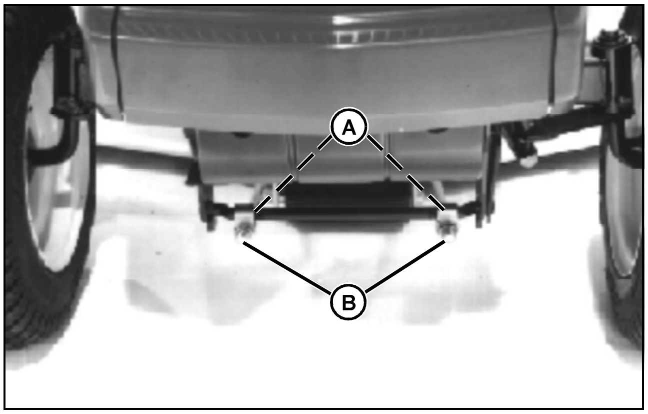
42C Mower
Front-to-Rear Blade
Height Difference . . . . 3 - 9 mm (0.125 - 0.375 in.)

Results:

- If the blade front-to-rear height difference is out of specification, adjust as follows.

NOTE: On 38, and 42-Inch decks equipped with a bagger, adjust front-to-rear height difference to maximum specification [9 mm (0.375 in.)] for best possible bagger performance.

Adjustment Procedure:



M82726

1. Loosen REAR nuts (A) on front draft rod.
2. Turn FRONT nuts (B) clockwise to raise front of mower deck or counterclockwise to lower front of mower deck.
3. Measure blade tip height (front and rear).
4. Tighten REAR nuts to lock deck height.

Timing Belt Adjustment - 42-Inch Mulching Deck

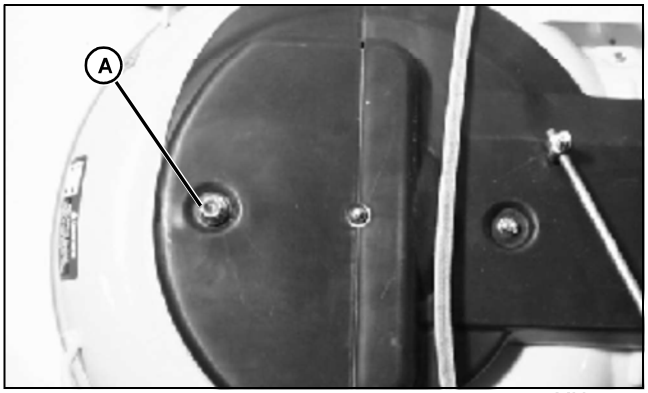
Procedure:

CAUTION: Avoid injury! To avoid injury, before you adjust mower: STOP engine, remove key, wait for blades to STOP. Be careful, sharp edges on mower blades. Always wear gloves when handling mower blades.

1. Park machine safely.

2. Move lift lever to mowing position, and move to left side of mower.

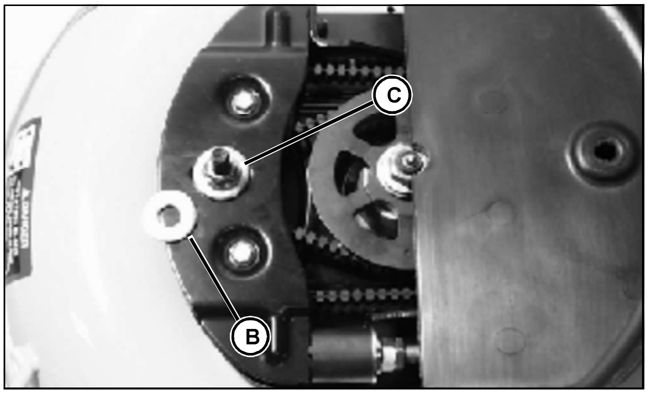
NOTE: Mower timing belt cover can be unfastened and flipped open on the left side, exposing the tension adjustment mechanism, without having to remove the mower or the timing belt cover.



MX1343

Picture Note: Mower deck removed for clarity

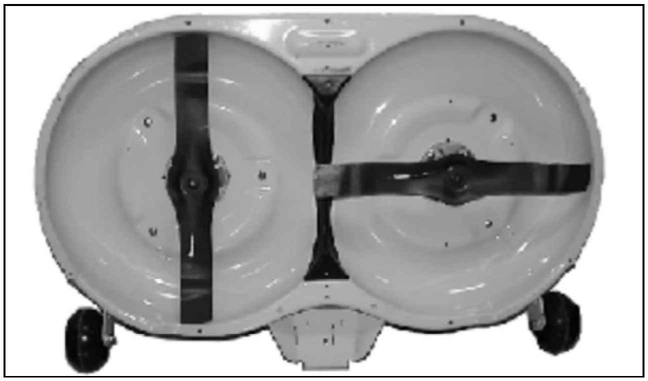
3. Remove flange locknut (A) to flip open left spindle cover.



MX1344

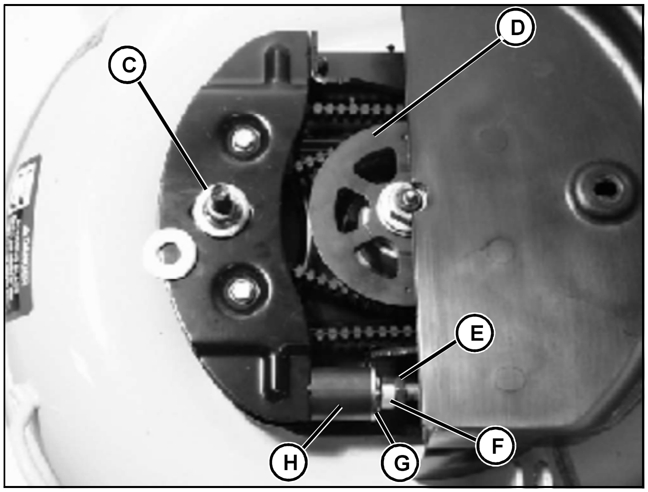
4. Checking timing belt for damage. If the belt is damaged, replace the timing belt.

5. Remove top washer (B) first, then loosen idler assembly center nut (C) ONE FULL TURN ONLY.



MX1374

6. Check that blades are timed properly (90° from each other). If blades are out of time, set blades to proper timing.



MX1344

7. Turn left spindle sprocket (D) to be sure belt is seated properly in the sprockets and idlers.

IMPORTANT: Avoid damage! Incorrect belt tensioning can cause belt damage. Do not over tighten belt tensioning spring assembly.

8. Loosen jam nut (E) and adjusting nut (F) so that there is a small air gap between washer (G) and mating surface of spring bushing (H).

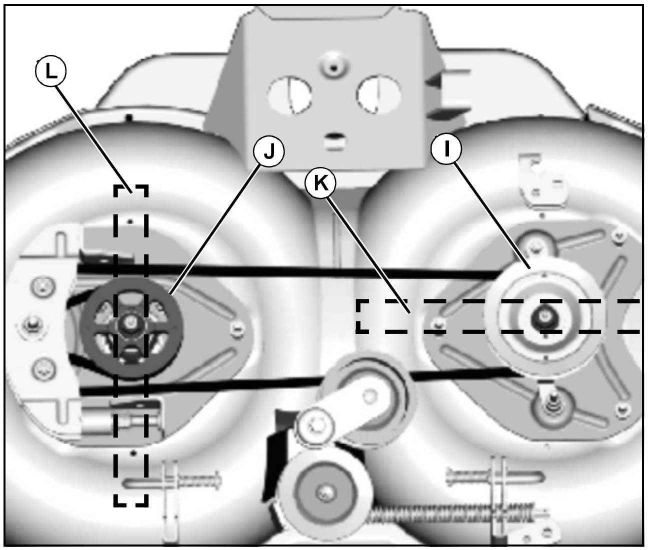
9. Rotate adjusting nut (F) clockwise until washer (G) makes solid contact with the mating surface of spring bushing (H).

10.Tighten idler assembly center nut (C) to 87 N•m (64 lb-ft).

11.Tighten jam nut (E) against adjusting nut (F) to 27 N•m (20 lb-ft).

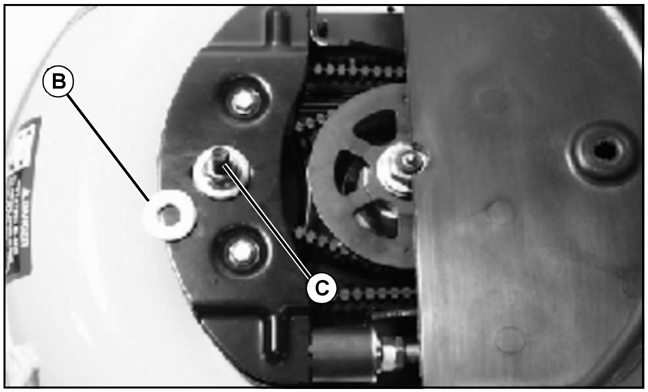
12.Turn left spindle sprocket (D) to be sure belt is seated properly in the sprockets and idlers.

NOTE: The position of the drain holes in the spindle sheave (I) and the indentations in the timing sprocket (J) are in alignment with the mower blades (K) and (L).



MX3867

13.Check that blades are timed properly (90° from each other). If blades are out of time, set blades to proper timing.



MX1344

14.Install top washer (B) on top of center nut (C) and close left spindle cover.

15.Fasten cover with flange locknut and tighten to 14 N•m (10 lb-ft).

Repair

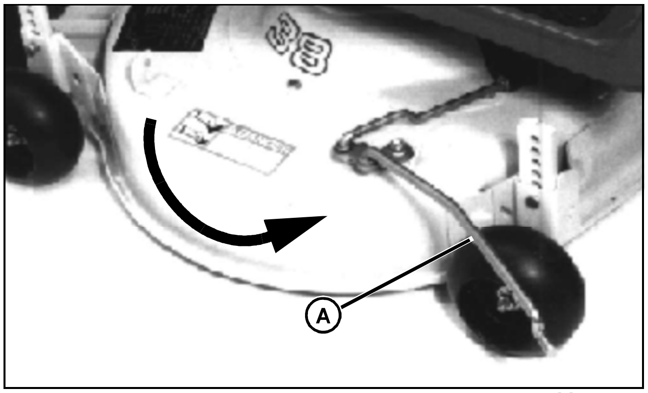
38-Inch Mower Deck Removal and Installation

CAUTION: Avoid injury! ROTATING BLADES/ MOVING PARTS. STOP engine. Remove ignition key. Wait for all moving parts to STOP.

1. Pull lift lever rearward and lock mower deck in the RAISE position.

2. Turn mower depth control knob to blank mark. Put wood blocks under each side of mower deck.

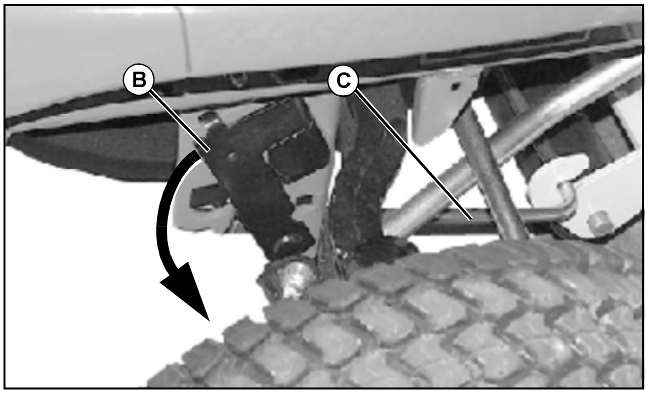
3. Move lift lever all the way forward and lock in the full LOWER position. Deck should be in contact with the blocks.



M54688

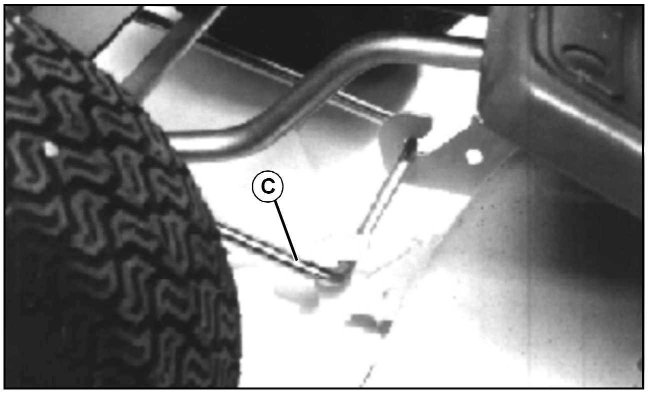
4. Disconnect tensioner handle (A) from bracket and pull handle out to relieve belt tension.

5. Remove drive belt from PTO and mower jack sheave.



M95512

6. Pull out and push down on lock lever (B) to disconnect front draft rod assembly (C) from frame.

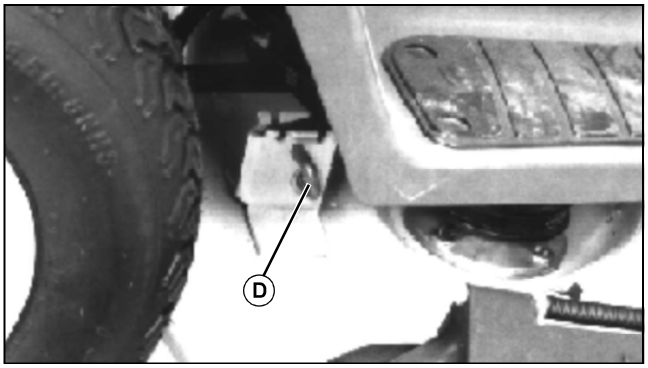


M54690

7. Remove draft rod assembly (C) from machine.

CAUTION: Avoid injury! SUDDEN DRAFT ARM MOVEMENT. Draft arms will raise suddenly if mower deck is disconnected without locking lift mechanism in the DOWN position. Do not remove mower deck J-pins unless lift lever is moved all the way forward and locked.

NOTE: It may be necessary to lift up on rear of mower deck to pull out J-Pins.



M54691

8. Pull out J-pin (D) on each side of mower deck and turn pin to unlock position.

CAUTION: Avoid injury! SUDDEN LIFT LEVER MOVEMENT. With no weight on draft arms, spring will pull lift lever rearward when lock button is pressed. Use caution when releasing lift spring tension to minimize the risk of personal injury.

9. Pull lift lever all the way rearward to the RAISE position.

10.Slide mower deck out the right side of the machine.

Installation:

Installation is the reverse of removal.

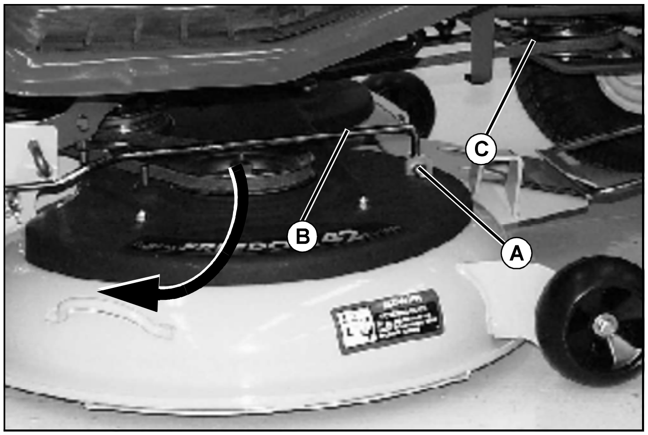
42-Inch Mulching Deck Removal and Installation

CAUTION: Avoid injury! ROTATING BLADES/ MOVING PARTS. STOP engine. Remove ignition key. Wait for all moving parts to STOP.

1. Pull lift lever rearward and lock mower deck in the RAISE position.

2. Turn mower depth control knob to blank mark. Put wood blocks under each side of mower deck.

3. Move lift lever all the way forward and lock in the full LOWER position. Deck should be in contact with the blocks.

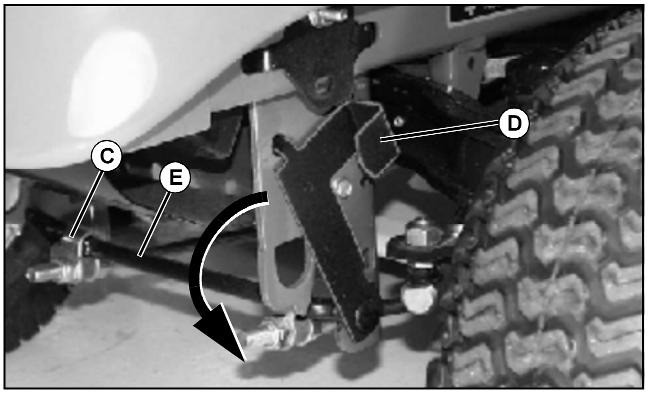


MX0237

4. Disconnect tensioner handle (B) from bracket (A). Pull handle out to relieve belt tension, and move rod towards rear of machine to relieve all of belt tension.

5. Remove drive belt (C) from engine drive sheave.

CAUTION: Avoid injury! SUDDEN LIFT ARM MOVEMENT. Draft arms will raise suddenly if mower deck is disconnected without locking lift mechanism in the DOWN position. Do not remove mower deck J-pins unless lift lever is moved all the way forward and locked.

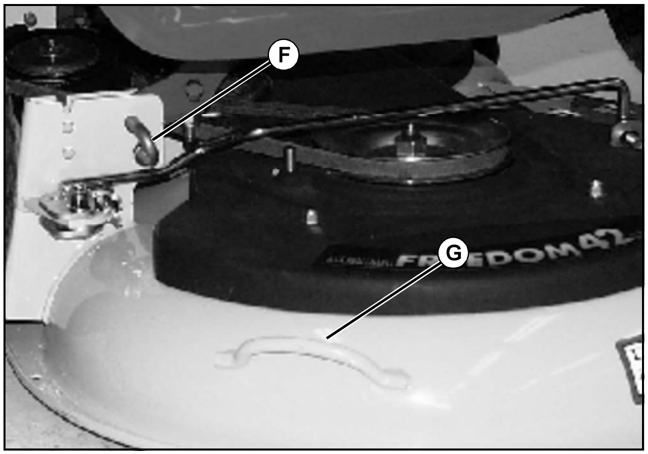


M95976

6. Pull out and rotate lock lever (D) on pivot (C) to disconnect front draft rod assembly.

7. Remove draft rod assembly (E) from frame and mower deck.

NOTE: It may be necessary to lift up on rear of mower deck to pull out J-pins.



MX3862

8. Lift up on rear of mower using handle (G). Pull outward on J-Pin (F) to disconnect draft arms.

CAUTION: Avoid injury! SUDDEN LIFT LEVER MOVEMENT. With no weight on draft arms, spring will pull lift lever rearward when lock button is pressed. Use caution when releasing lift spring tension to minimize the risk of personal injury.

9. Push lift lever forward against spring tension, and press in release button. Move lift lever rearward, and lock in the RAISE position.

10.Slide mower deck out the right side of the machine.

Installation:

Installation is the reverse of removal.

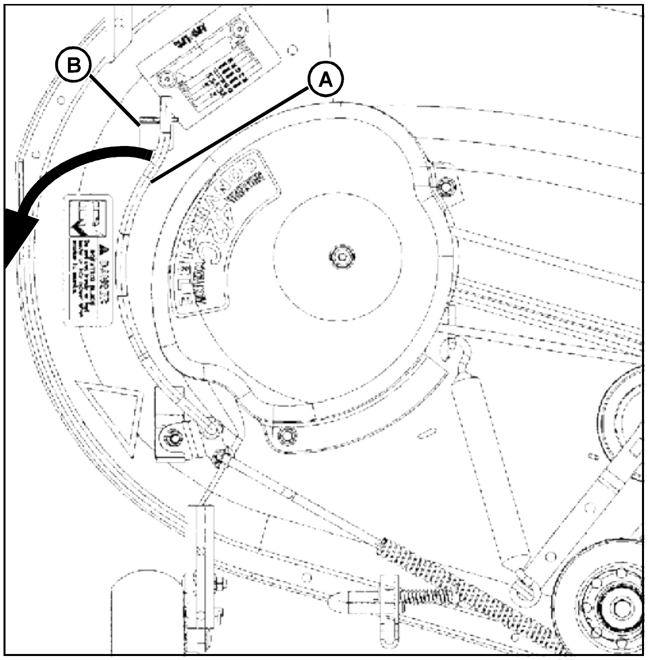
42-Inch Convertible Mower Deck Removal and Installation

CAUTION: Avoid injury! ROTATING BLADES/ MOVING PARTS. STOP engine. Remove ignition key. Wait for all moving parts to STOP.

1. Pull lift lever rearward and lock mower deck in the RAISE position.

2. Turn mower depth control knob to blank mark. Put wood blocks under each side of mower deck.

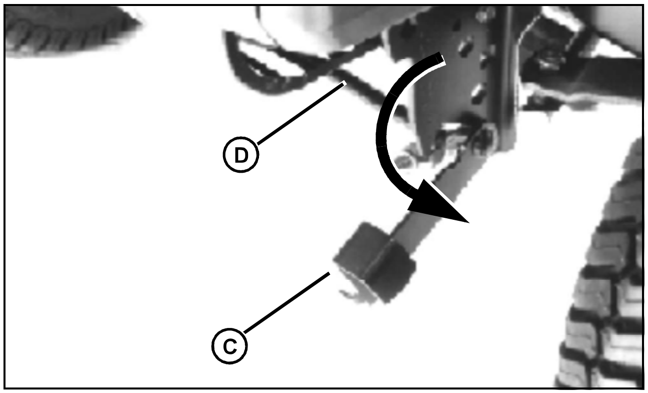
3. Move lift lever all the way forward and lock in the full LOWER position. Deck should be in contact with the blocks.



M99567

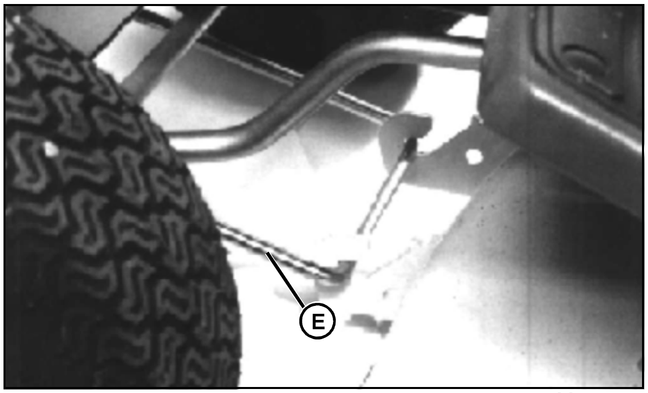
4. Disconnect tensioner handle (A) from bracket (B). Pull handle out to relieve belt tension.

5. Remove drive belt from PTO and mower jack sheave.



M82728

6. Pull out and rotate lock lever (C) on pivot (D) to disconnect front draft rod assembly.

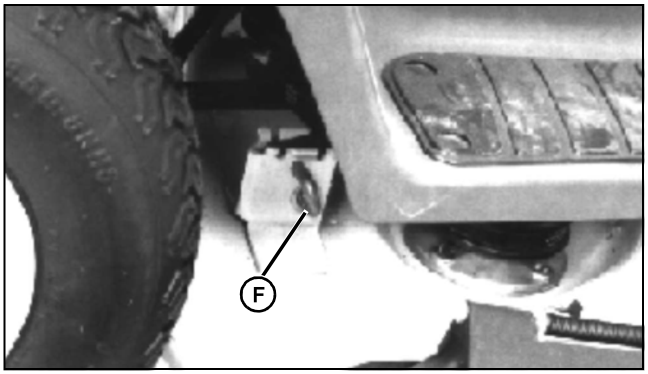


M54690

7. Remove draft rod assembly (E) from machine.

CAUTION: Avoid injury! SUDDEN LIFT ARM MOVEMENT. Draft arms will raise suddenly if mower deck is disconnected without locking lift mechanism in the DOWN position. Do not remove mower deck J-pins unless lift lever is moved all the way forward and locked.

NOTE: It may be necessary to lift up on rear of mower deck to pull out J-pins (F).



M54691

8. Pull out J-pin (F) on each side of mower deck and turn pin to unlock position.

9. Push lift lever forward against spring tension, and press in release button. Move lift lever rearward, and lock in the RAISE position.

10. Slide mower deck out the right side of the machine.

Installation:

Installation is the reverse of removal.

44-Inch Mower Deck Removal and Installation

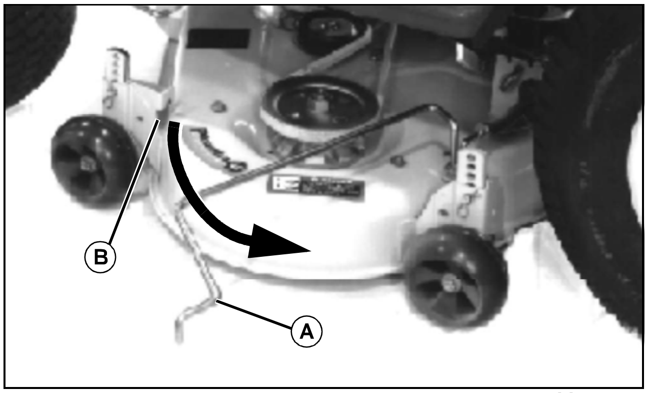
CAUTION: Avoid injury! ROTATING BLADES/ MOVING PARTS. STOP engine. Remove ignition key. Wait for all moving parts to STOP.

1. Pull lift lever rearward and lock mower deck in the RAISE position.

2. Turn mower depth control knob to blank mark. Put wood blocks under each side of mower deck.

3. Move lift lever all the way forward and lock in the full LOWER position. Deck should be in contact with the blocks.

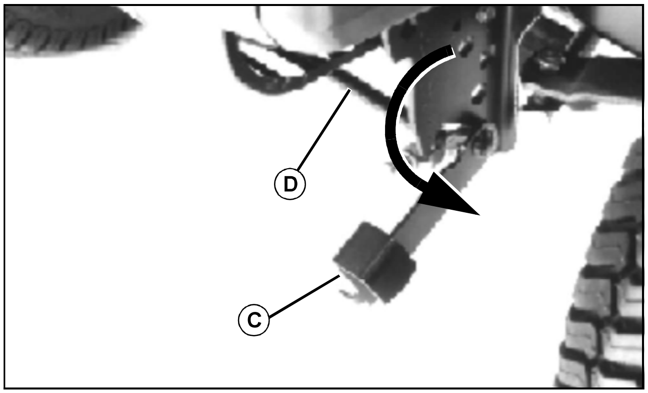
4. Remove two wing nuts and rear deflector.



M82732

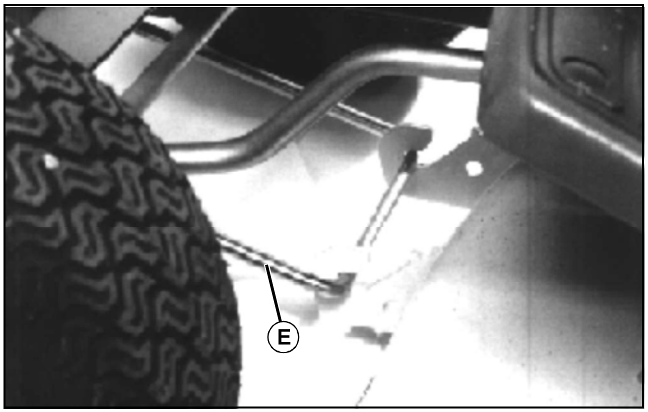
5. Disconnect tensioner handle (A) from bracket (B). Pull handle out to relieve belt tension.

6. Remove drive belt from PTO and mower jack sheave.



M82728

7. Pull out and rotate lock lever (C) on pivot (D) to disconnect front draft rod assembly.

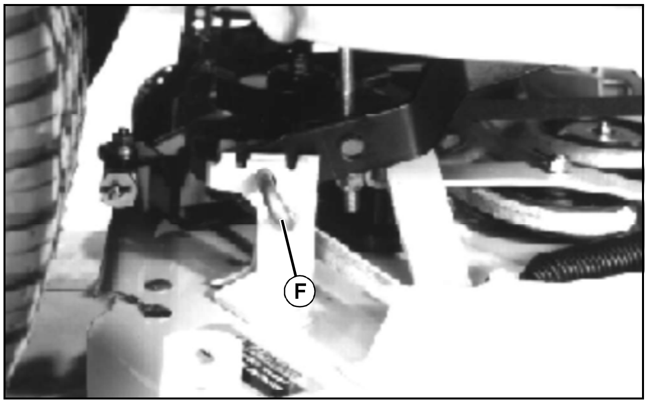


M54690

8. Remove draft rod assembly (E) from machine.

CAUTION: Avoid injury! SUDDEN LIFT ARM MOVEMENT. Draft arms will raise suddenly if mower deck is disconnected without locking lift mechanism in the DOWN position. Do not remove mower deck J-pins unless lift lever is moved all the way forward and locked.

NOTE: It may be necessary to lift up on rear of mower deck to pull out J-pins.



M82733

9. Pull out J-pin (F) on each side of mower deck and turn pin to unlock position.

CAUTION: Avoid injury! SUDDEN LIFT LEVER MOVEMENT. With no weight on draft arms, spring will pull lift lever rearward when lock button is pressed. Use caution when releasing lift spring tension to minimize the risk of personal injury.

10. Push lift lever forward against spring tension, and press in release button. Move lift lever rearward, and lock in the RAISE position.

11. Slide mower deck out the right side of the machine.

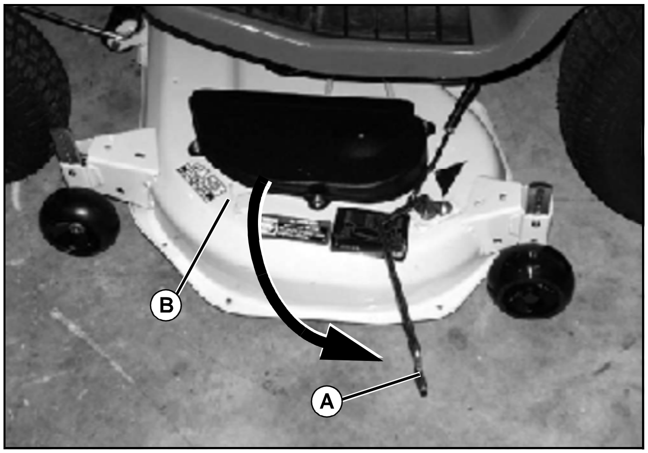
Installation:

Installation is the reverse of removal.

48-Inch Convertible Mower Deck Removal and Installation

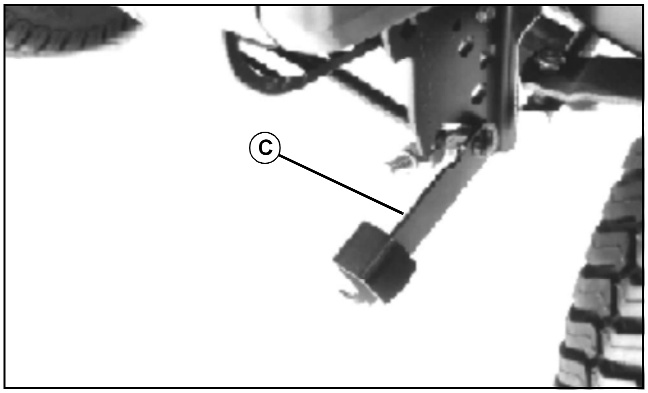
CAUTION: Avoid injury! ROTATING BLADES/ MOVING PARTS. STOP engine. Remove ignition key. Wait for all moving parts to STOP.

1. Pull lift lever rearward and lock mower deck in the RAISE position.
2. Turn mower depth control knob to blank mark. Put wood blocks under each side of mower deck.
3. Move lift lever all the way forward and lock in the full LOWER position. Deck should be in contact with the blocks.



M95465

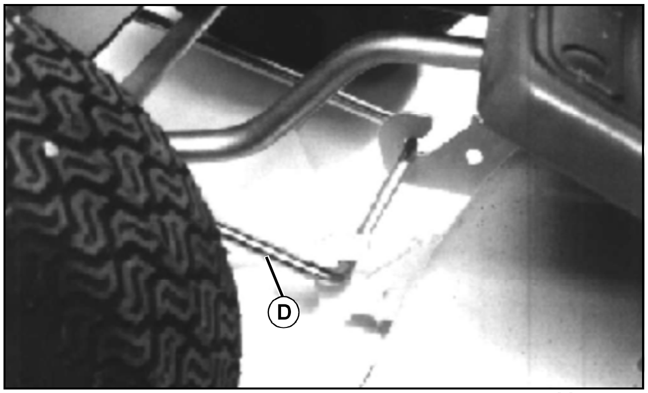
4. Disconnect tensioner handle (A) from bracket (B). Pull handle out to relieve belt tension.
5. Remove drive belt from PTO and mower jack sheave.



M82728

6. Pull out and push down on lock lever (C) to disconnect front draft rod assembly.

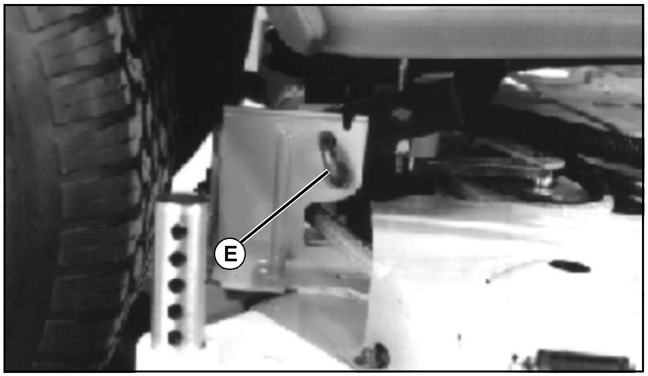
CAUTION: Avoid injury! SUDDEN DRAFT ARM MOVEMENT. Draft arms will raise suddenly if mower deck is disconnected without locking lift mechanism in the DOWN position. Do not remove mower deck J-pins unless lift lever is moved all the way forward and locked.



M54690

7. Remove draft rod assembly (D) from machine.

NOTE: It may be necessary to lift up on rear of mower deck to pull out J-pins.



M82740

8. Pull out J-pin (E) on each side of mower deck and turn pin to unlock position.

CAUTION: Avoid injury! SUDDEN LIFT LEVER MOVEMENT. With no weight on draft arms, spring will pull lift lever rearward when lock button is pressed. Use caution when releasing lift spring tension to minimize the risk of personal injury.

9. Pull lift lever all the way back to full raised position.

10. Slide mower deck out the left side of the machine.

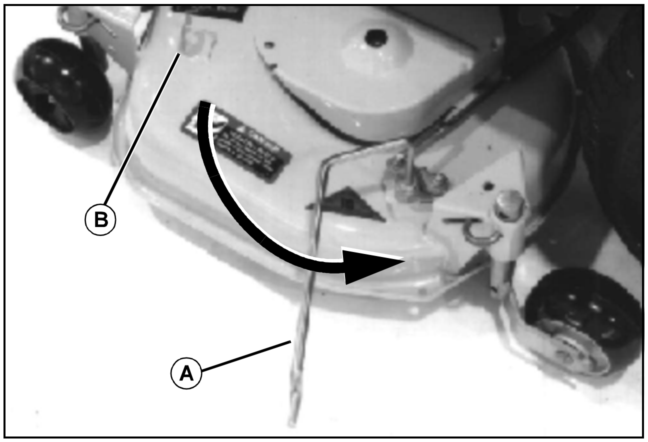
Installation:

Installation is the reverse of removal.

54-Inch Mower Deck Removal and Installation

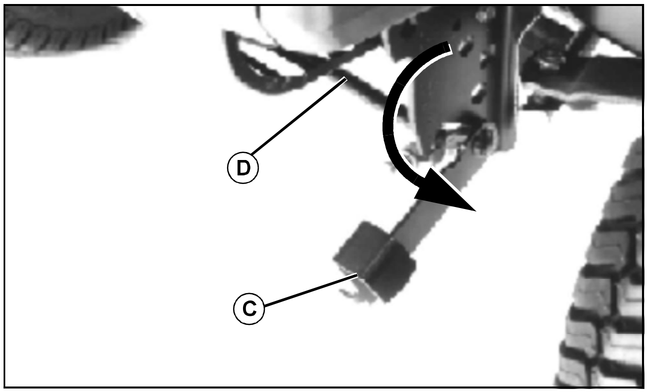
CAUTION: Avoid injury! ROTATING BLADES/ MOVING PARTS. STOP engine. Remove ignition key. Wait for all moving parts to STOP.

1. Pull lift lever rearward and lock mower deck in the RAISE position.
2. Turn mower depth control knob to blank mark. Put wood blocks under each side of mower deck.
3. Move lift lever all the way forward and lock in the full LOWER position. Deck should be in contact with the blocks.



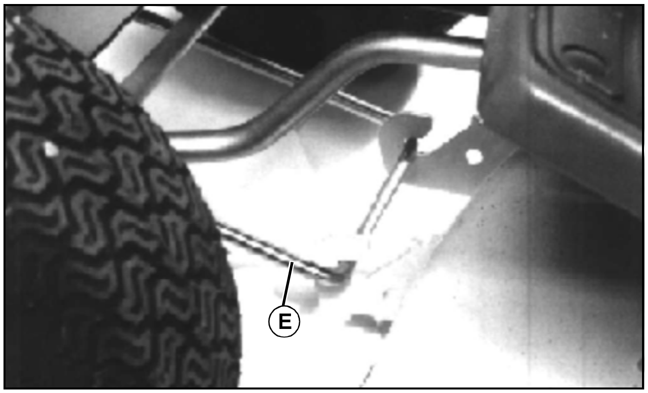
M82731

4. Disconnect tensioner handle (A) from bracket (B). Pull handle out to relieve belt tension.
5. Remove drive belt from PTO and mower jack sheave.



M82728

6. Pull out and rotate lock lever (C) on pivot (D) to disconnect front draft rod assembly.

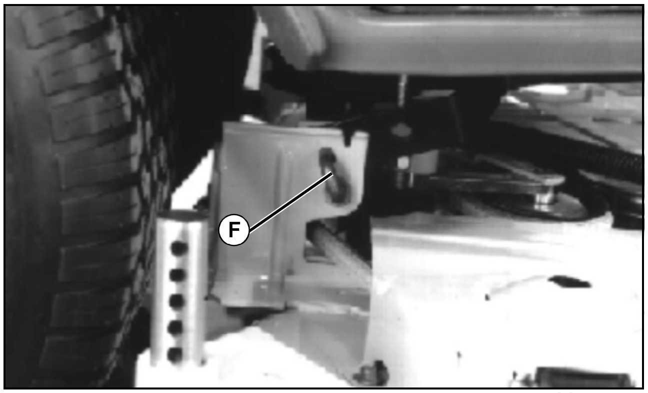


M54690

7. Pull out and push down on pivot (C) to disconnect front draft rod assembly (D). Remove draft rod assembly (E) from machine.

CAUTION: Avoid injury! SUDDEN LIFT ARM MOVEMENT. Draft arms will raise suddenly if mower deck is disconnected without locking lift mechanism in the DOWN position. Do not remove mower deck J-pins unless lift lever is moved all the way forward and locked

NOTE: It may be necessary to lift up on rear of mower deck to pull out J-pins.



M82740

8. Pull out J-pin (F) on each side of mower deck and turn pin to unlock position.

CAUTION: Avoid injury! SUDDEN LIFT LEVER MOVEMENT. With no weight on draft arms, spring will pull lift lever rearward when lock button is pressed. Use caution when releasing lift spring tension to minimize the risk of personal injury.

9. Push lift lever forward against spring tension, and press in release button. Move lift lever rearward, and lock in the RAISE position.

10. Slide mower deck out the right side of the machine.

Installation:

Installation is the reverse of removal.

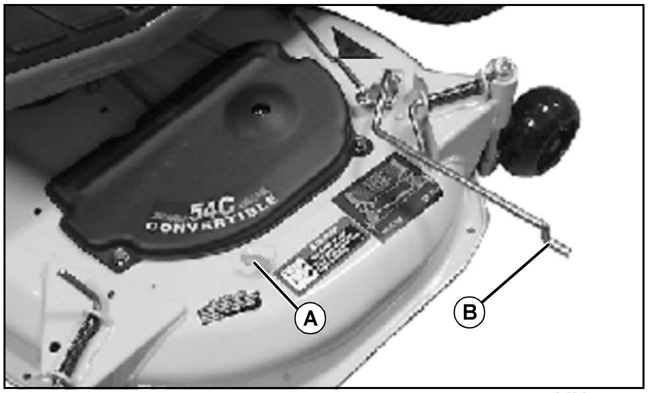
54-Inch Convertible Mower Deck Removal and Installation

CAUTION: Avoid injury! ROTATING BLADES/ MOVING PARTS. STOP engine. Remove ignition key. Wait for all moving parts to STOP.

1. Pull lift lever rearward and lock mower deck in the RAISE position.

2. Turn mower depth control knob to blank mark. Put wood blocks under each side of mower deck.

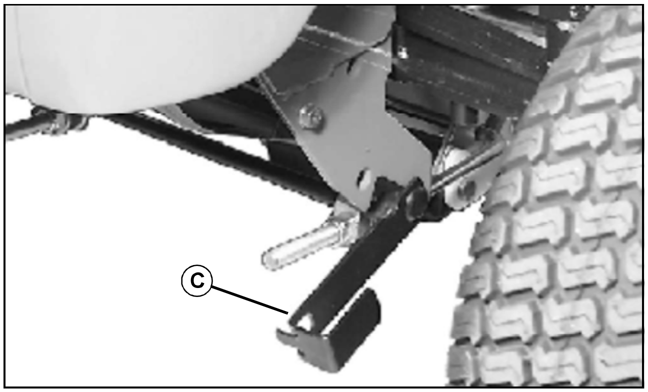
3. Move lift lever all the way forward and lock in the full LOWER position. Deck should be in contact with the blocks.



MX9574

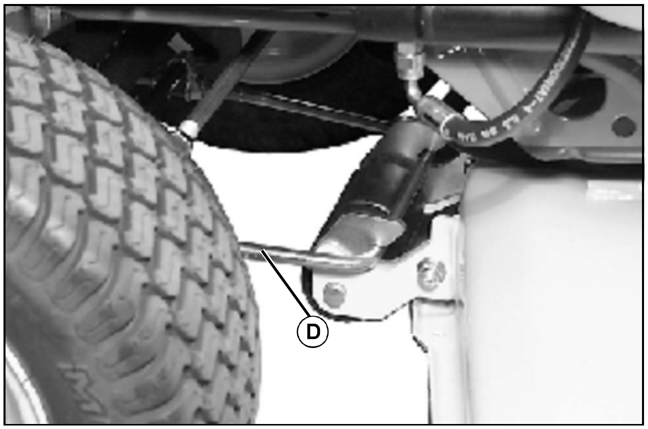
4. Disconnect tensioner handle (A) from bracket (B). Pull handle out to relieve belt tension.

5. Remove drive belt from PTO and mower jack sheave.



MX9575

6. Pull out and rotate lock lever (C) on pivot (D) to disconnect front draft rod assembly.

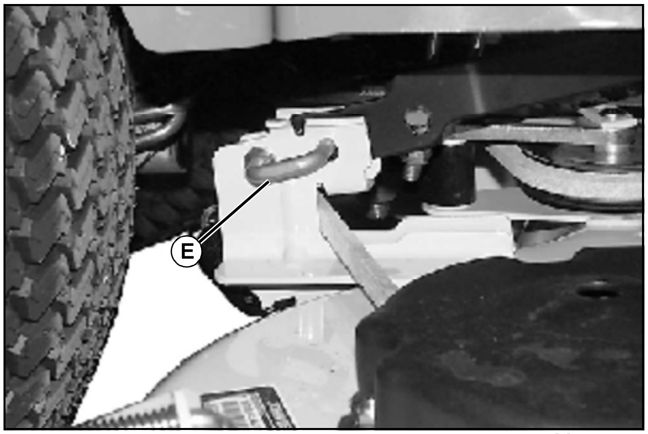


MX9576

7. Pull out and push down on pivot to disconnect front draft rod assembly (D). Remove draft rod assembly from machine.

CAUTION: Avoid injury! SUDDEN LIFT ARM MOVEMENT. Draft arms will raise suddenly if mower deck is disconnected without locking lift mechanism in the DOWN position. Do not remove mower deck J-pins unless lift lever is moved all the way forward and locked

NOTE: It may be necessary to lift up on rear of mower deck to pull out J-pins.



MX9577

8. Pull out J-pin (E) on each side of mower deck and turn pin to unlock position.

CAUTION: Avoid injury! SUDDEN LIFT LEVER MOVEMENT. With no weight on draft arms, spring will pull lift lever rearward when lock button is pressed. Use caution when releasing lift spring tension to minimize the risk of personal injury.

9. Push lift lever forward against spring tension, and press in release button. Move lift lever rearward, and lock in the RAISE position.

10.Slide mower deck out the right side of the machine.

Installation:

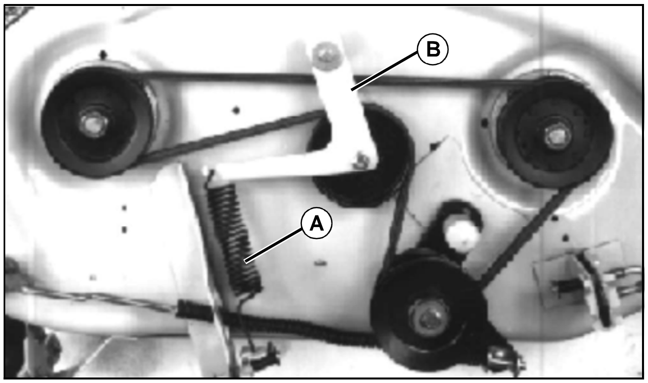
Installation is the reverse of removal.

38-Inch Drive Belt

CAUTION: Avoid injury! ROTATING BLADES/ MOVING PARTS. STOP engine. Remove ignition key. Wait for all moving parts to STOP

Removal:

1. Remove mower deck.
2. Remove belt cover.



M54674

3. Remove spring (A).
4. Remove mower drive belt (B).

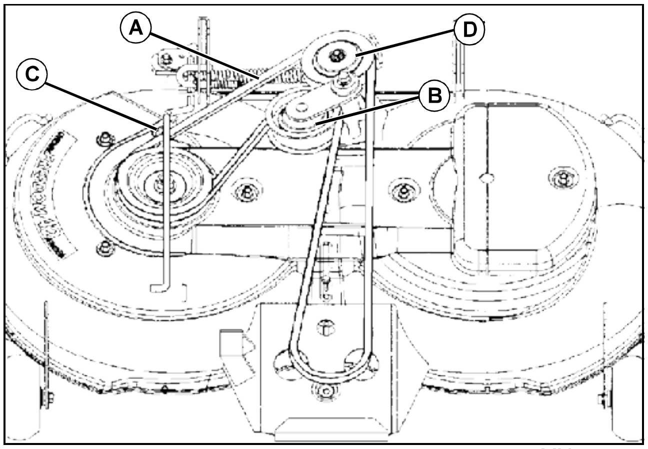
Installation:

Installation is the reverse of removal.

42-Inch Mulching Drive Belt

Removal and Installation:

1. Remove mower deck.



MX8412A

2. Loosen idler sheave (D) and tensioning sheave (B).

3. Remove drive belt (A). Inspect belt for wear or damage, and replace as necessary.

IMPORTANT: Avoid damage! Make sure belt is routed to the inside of belt guide (C) above.

4. Install belt in reverse order. Use picture above for belt routing.

5. Tighten idler sheave (D) and tensioner sheave (B).

6. Install mower deck.

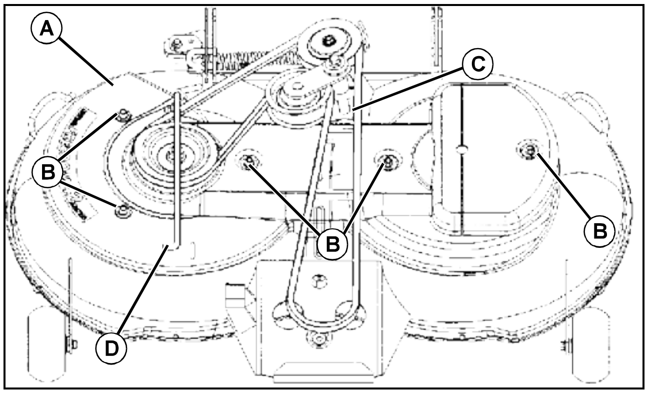
42-Inch Mulching Deck Timing Belt Replacement

Procedure:

CAUTION: Avoid injury! To avoid injury, before you adjust mower: STOP engine, remove key, wait for blades to STOP. Be careful of sharp edges on mower blades. Always wear gloves when handling mower blades.

1. Remove mower deck.

2. Check blade torque anytime mower is removed. Carefully hold blade with glove, use a hand torque wrench, and tighten bolt to 62 N•m (46 lb-ft).

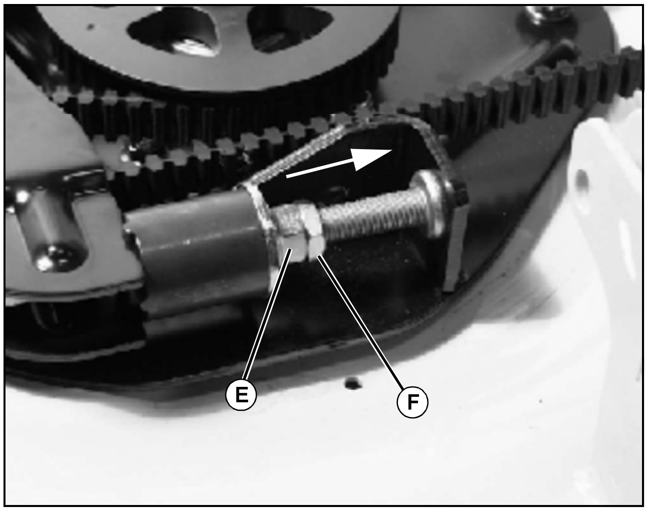


MX8412A

3. Remove mower drive belt (C).

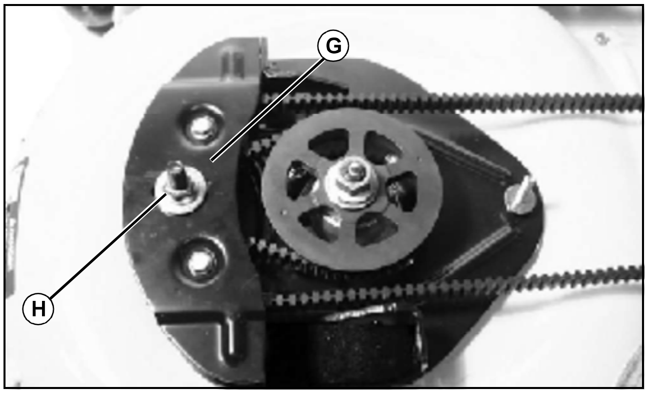
4. Move mower engagement rod assembly (D) back to clear timing belt cover.

5. Remove five flange locknuts (B) and cover (A).



MX1376

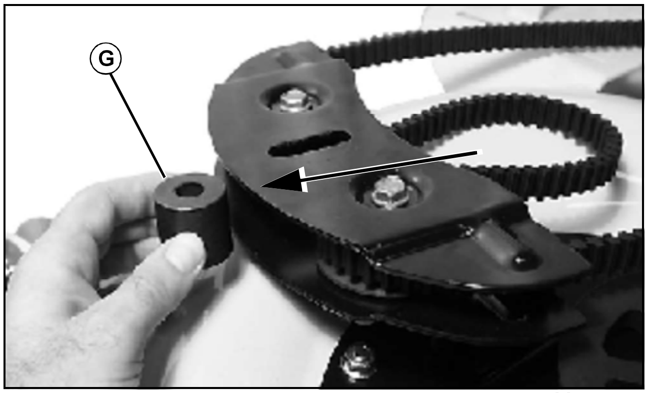
6. Turn jam nut (F) and adjusting nut (E) counterclockwise to end of threaded rod, and remove tensioning spring assembly.



MX1377

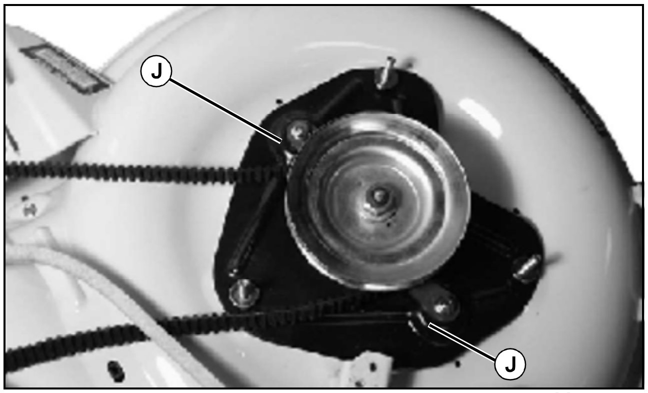
7. Remove center nut and washer (H) and move fixed idler assembly (G) close to the spindle sprocket. DO NOT loosen other idle assembly hardware.

8. Raise idler assembly upward as you carefully remove timing belt from the left spindle sprocket.



MX1378

9. Remove spacer (I) located between fixed idler assembly plates and carefully pull belt from assembly.

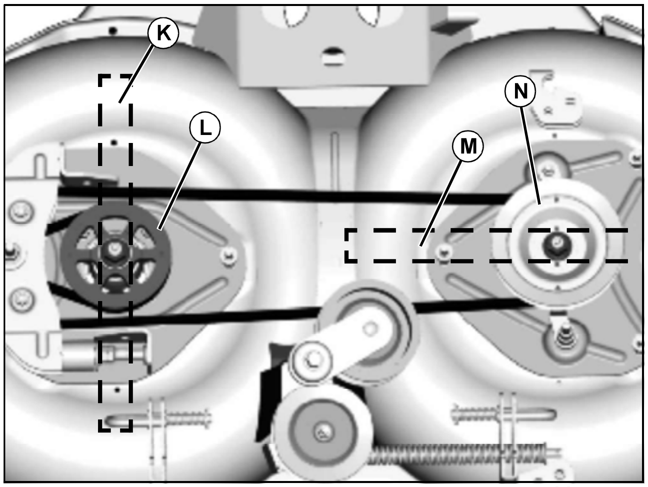


MX1379

10. Loosen two belts guides (J) and rotate away from left sprocket.

11. Remove timing belt. Replace if necessary.

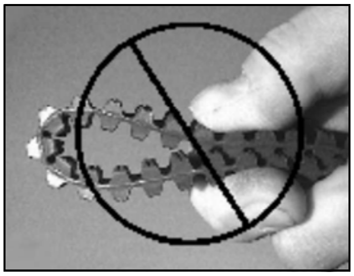
NOTE: The position of the drain holes in the spindle sheave (N) and the indentations in the timing sprocket (L) are in alignment with the mower blades (M) and (K).



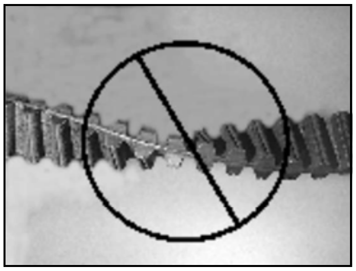
MX3867

12. Position mower blades (M) and (K) 90° from each other.

IMPORTANT: Avoid damage! Handle timing belts with care.

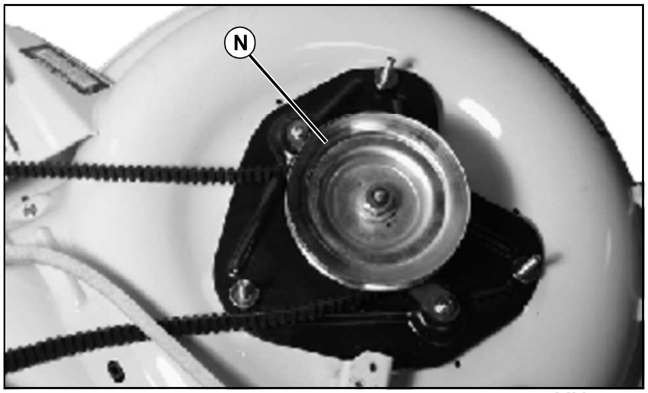


M92926A



M92927A

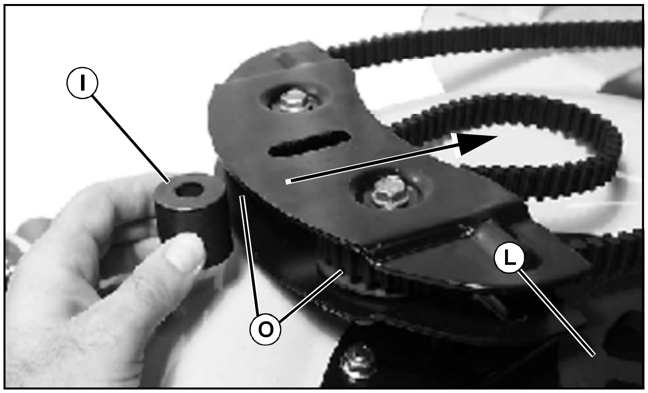
- DO NOT crimp.
- DO NOT fold.
- DO NOT twist.



MX1379

13. Install new mower deck timing belt:

    a. Route belt around right spindle sprocket located under the mower drive belt sheave (N).

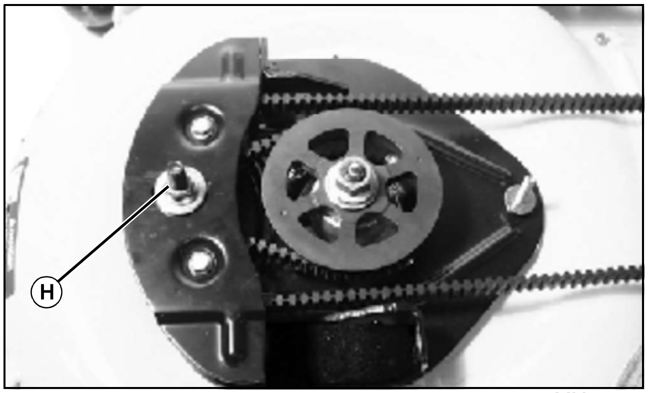


MX1378

b. Route belt around outside of idlers and then in between the fixed idlers (O), pulling a belt loop through the idler assembly.

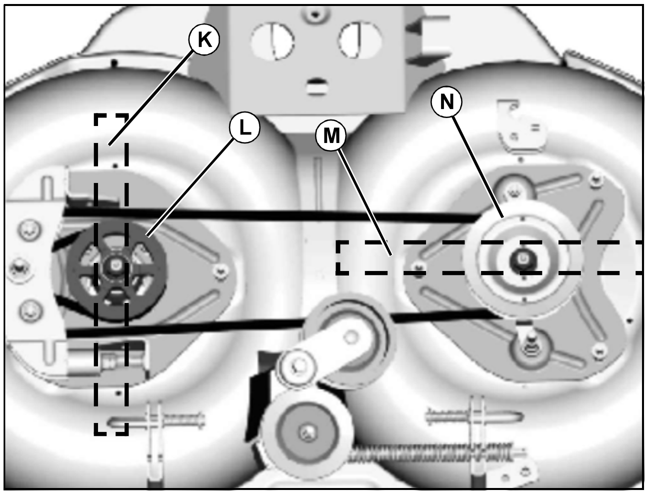
c. Insert spacer (I) between fixed idler plates and idlers.

d. Install fixed idler assembly on the stud of the left support plate as you wrap belt loop around left spindle sprocket (L).



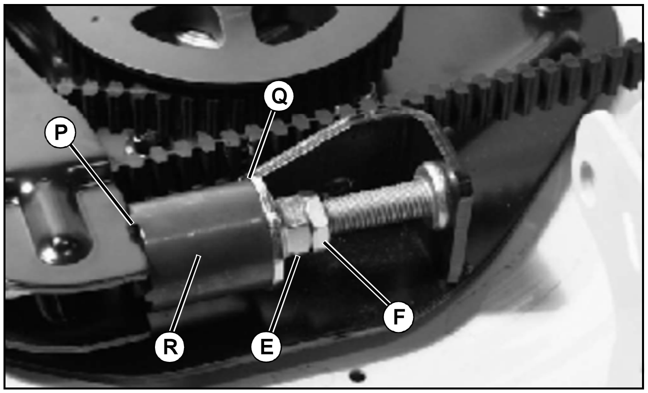
MX1377

14.Install washer and center nut (H) on fixed idler assembly. Leave nut loose at this time.



MX3867

15.Check that blades (M) and (K) are 90° from each other.



MX1376

16.Install tensioning spring assembly and adjust timing belt tension:

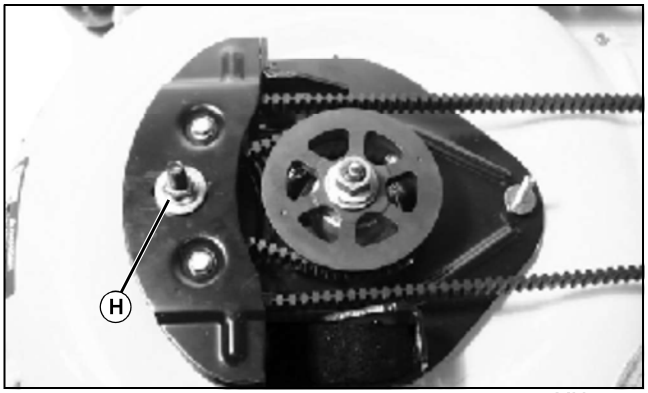
a. Align notch (P) in idler assembly with tab on spring bushing (R).

b. Rotate adjusting nut (E) clockwise until the washer (Q) makes solid contact with the surface of the spring bushing (R).

c. Turn adjusting nut an additional 1/2 turn to allow for new belt stretch. DO NOT over tighten.

d. Rotate right spindle sheave clockwise and observe that belt is riding properly in sprockets and idlers.

e. Tighten jam nut (F) against adjusting nut.

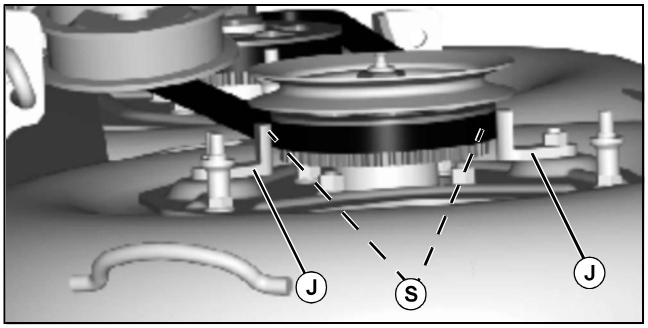


MX1377

17.Tighten center nut (H) to 73 N•m (54 lb-ft).

18.Install top washer on top of center nut.

IMPORTANT: Avoid damage! Check belt guide-to-sprocket rim clearance. Measuring clearance incorrectly can cause belt or blade damage.

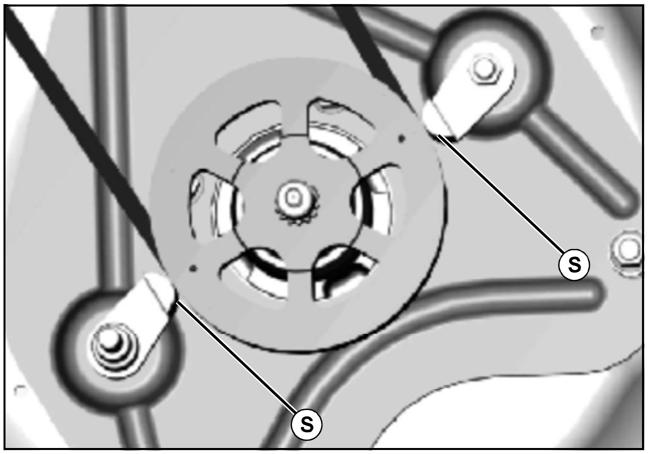


MX0235

19.Adjust belt guides.

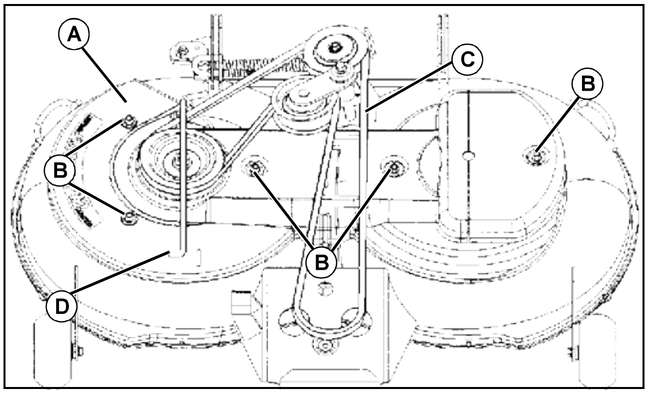
a. Hold a 1 mm (0.039 in.) shim/gage between belt guides and sprocket rim, location (S), and rotate belt guides (J) clockwise against gage.

b. Tighten belt guide nuts to 24 N•m (18 lb-ft).



MX3861

c. Remove gage. Clearance (S), one on each side, should be 1 ± 0.5 mm (0.039 ± 0.020 in.). Belt should not contact belt guide.



MX8412A

20.Install timing belt cover (A) and fasten with five nuts (B). Tighten nuts to 14 N•m (10 lb-ft).

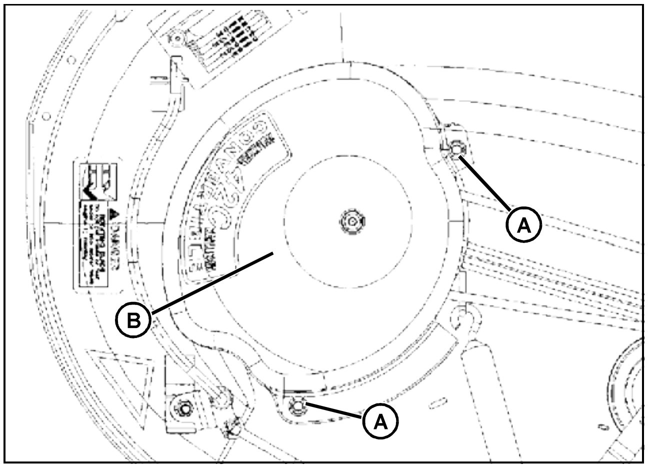
21.Install mower drive belt (C).

22.Tighten mower engagement rod (D) and clip into welded tab on mower deck.

42-Inch Drive Belt

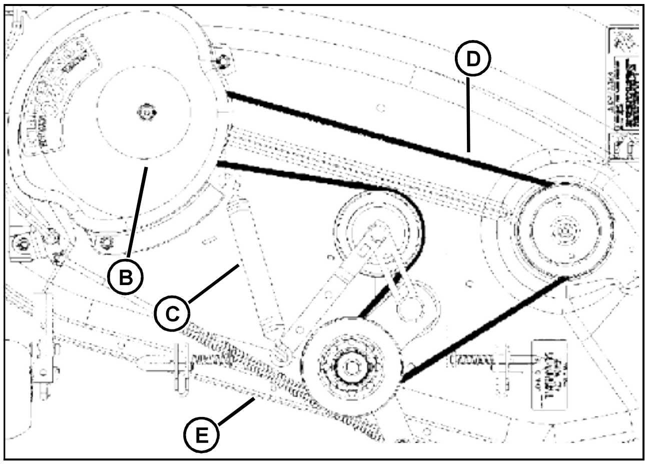
Removal:

CAUTION: Avoid injury! ROTATING BLADES/ MOVING PARTS. STOP engine. Remove ignition key. Wait for all moving parts to STOP



M99568

1. Remove two cap screws (A) and belt cover (B).



M99569

2. Remove spring (C) using a spring puller.
3. Remove mower drive belt (D).

Installation:

Installation is the reverse of removal.

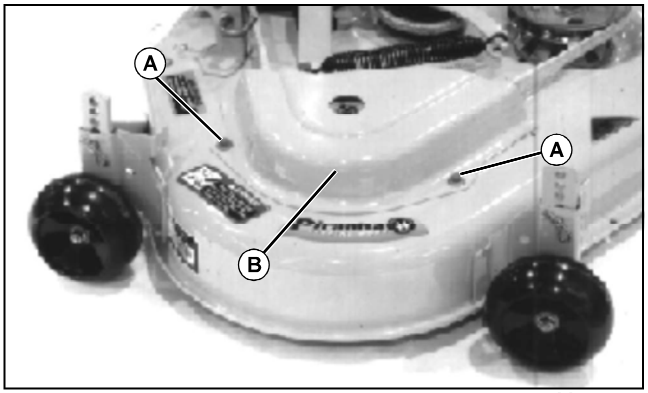
IMPORTANT: Avoid damage! When installing, be sure to install spring hook (E) on secondary spring arm (F) as shown.

44-Inch Piranha Mower Drive Belt

CAUTION: Avoid injury! ROTATING BLADES/ MOVING PARTS. STOP engine. Remove ignition key. Wait for all moving parts to STOP

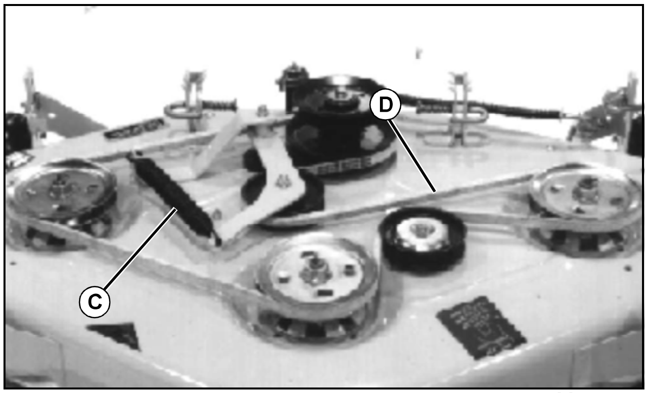
Removal:

1. Remove mower deck.



M82738

2. Remove cap screws (A) and belt cover (B).



M82745

3. Remove spring (C) using a spring puller.
4. Remove mower drive belt (D).

Installation:

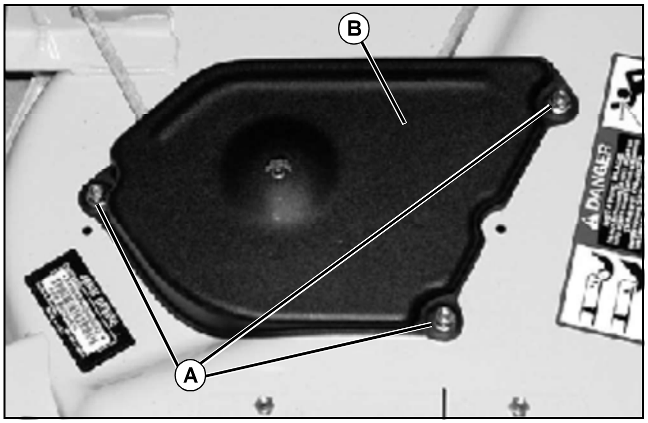
Installation is the reverse of removal.

48-Inch Mower Drive Belt

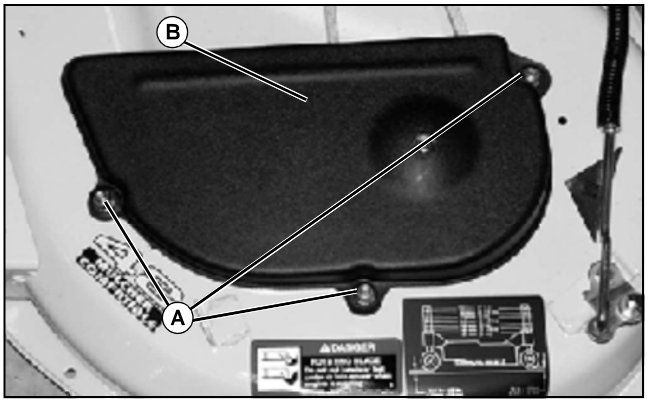
CAUTION: Avoid injury! ROTATING BLADES/ MOVING PARTS. STOP engine. Remove ignition key. Wait for all moving parts to STOP.

Removal:

1. Remove mower deck.

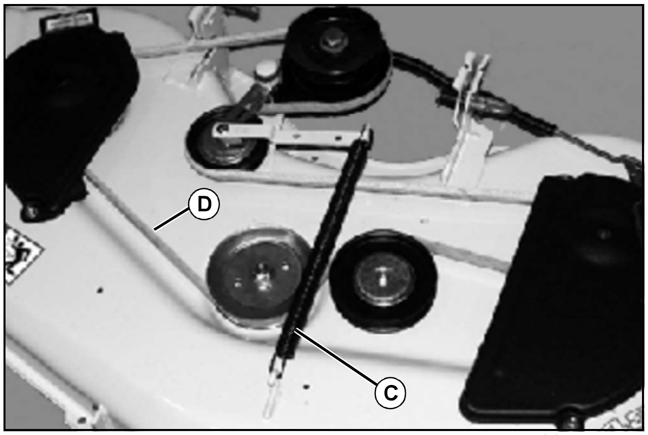


M95467



M95466

2. Remove nuts (A) and belt covers (B) from both the right and left side of the mower deck.



M95468A

3. Disconnect spring (C) using a spring puller.
4. Replace mower drive belt (D).

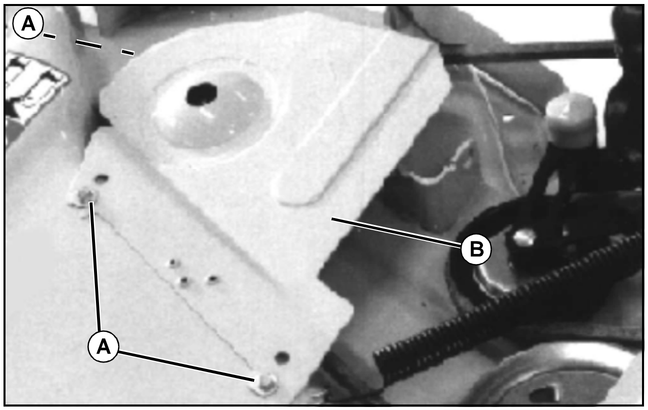
Installation:

Installation is the reverse of removal.

54-Inch Mower Drive Belt

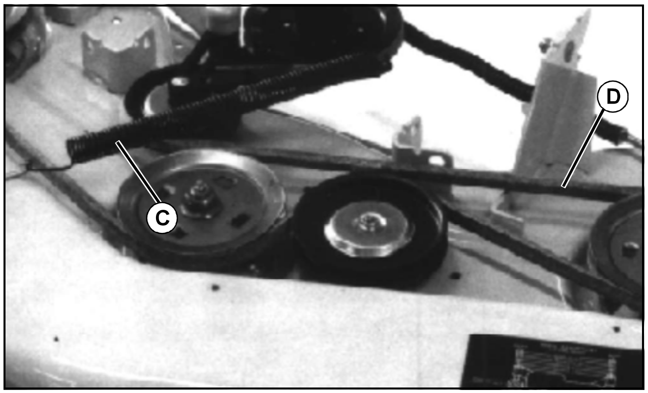
Removal and Installation:

1. Remove mower deck.



M74253

2. Remove cap screws (A) and belt cover (B).



M74255

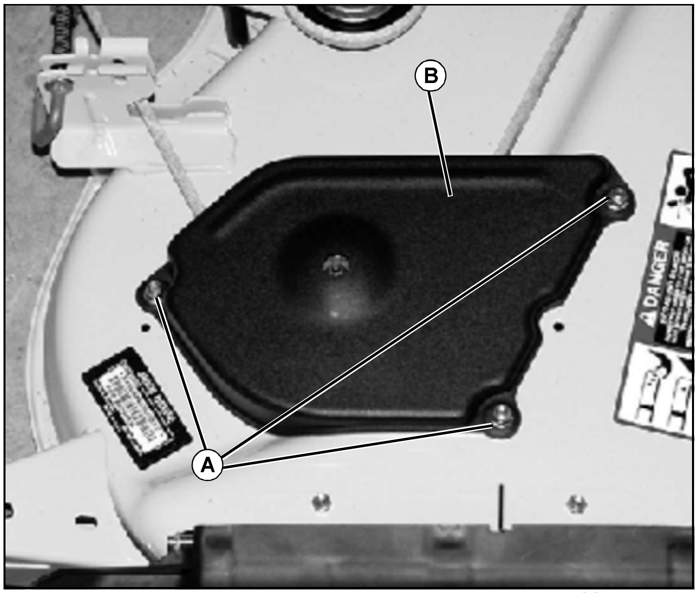
3. Disconnect spring (C) using a spring puller.
4. Replace mower drive belt (D).

Installation is the reverse of removal.

54-Inch Convertible Mower Drive Belt

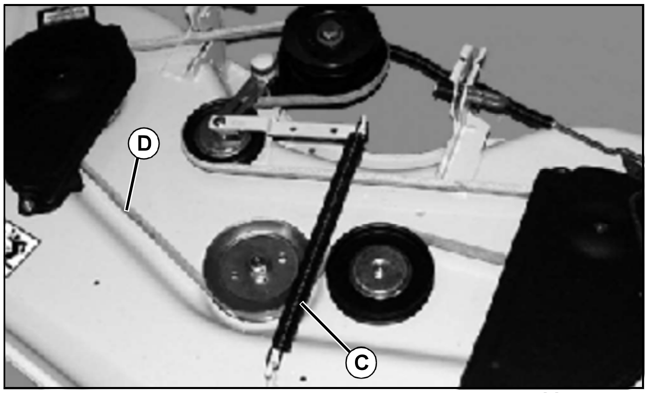
Removal and Installation:

1. Remove mower deck.



M95467

2. Remove cap screws (A) and belt cover (B).



M95468A

3. Disconnect spring (C) using a spring puller.
4. Replace mower drive belt (D).

Installation is the reverse of removal.

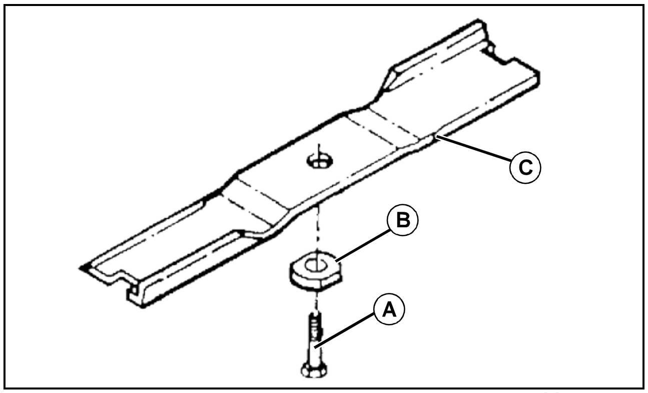
38-Inch Deck Mower Blades

Removal and Installation:

CAUTION: Avoid injury! ROTATING BLADES/ MOVING PARTS. STOP engine. Remove ignition key. Wait for all moving parts to STOP.

1. Remove mower deck.

CAUTION: Avoid injury! SHARP EDGES. Wear gloves or wrap blade with a shop towel when removing/installing blades. DO NOT hold blade with bare hands.



M82898A

2. Remove cap screw (A), washer (B), and blade (C).

3. Inspect blade for cracks, wear or damage. Replace blade if necessary.

4. Sharpen and balance as necessary.

Installation:

Installation is the reverse of removal.

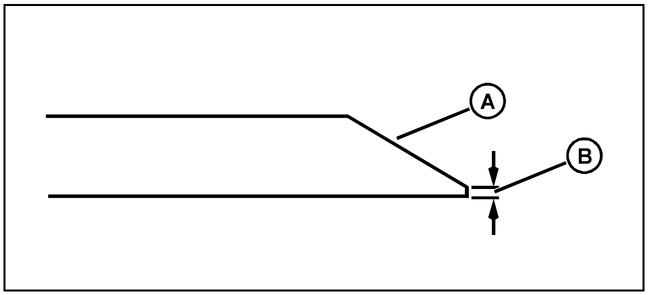
IMPORTANT: Avoid damage! Make sure that concave side of washer faces blade.

- Install blade with bent tips up.
- Tighten cap screw to 75 N•m (55 lb-ft).

Sharpen:

CAUTION: Avoid injury! FLYING SPARKS/ METAL FRAGMENTS, SHARP EDGES. Wear approved eye protection and gloves when sharpening blades to minimize the risk of personal injury.

1. Sharpen blades using grinder, file, or power sharpener.



MIF

2. Do not alter original bevel (A). Blade should have 0.40 mm (0.016 in.) cutting edge (B) rather than a razor-type edge to prevent excessive chipping of the cutting edge.

NOTE: If excessive browning of ends of mown grass occurs or if mower is to be used on tough grasses it may be necessary to grind the blade to a sharp edge.

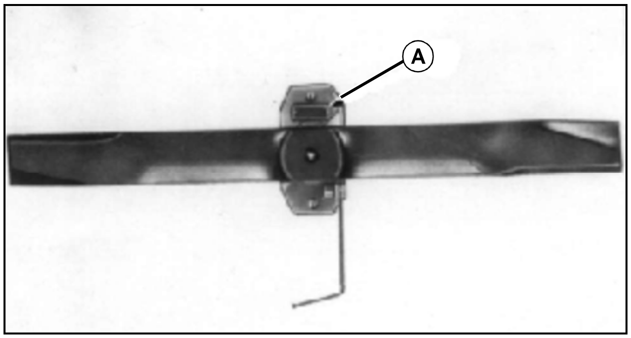
3. Balance blades.

Balance:

CAUTION: Avoid injury! SHARP EDGES. Wear gloves or wrap blade with a shop towel when handling blades. DO NOT hold blade with bare hands.

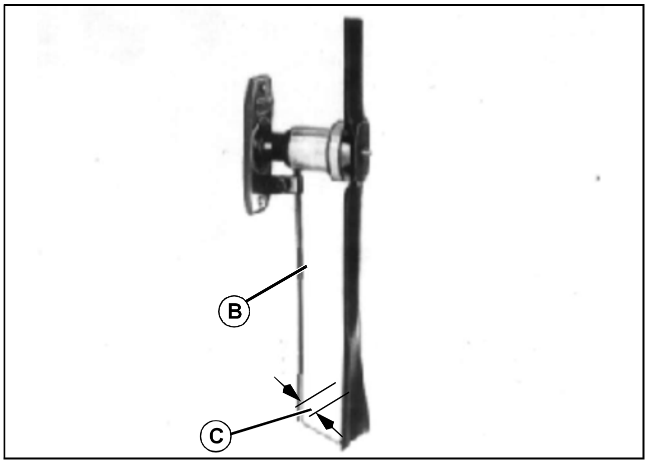
1. Sharpen blade, if needed.

2. Clean blade and remove any accumulated grass/dirt with scraper or wire brush and wipe blade clean.



M29627

3. Set blade on JT07076 Rotary Blade Balancer (A) and turn blade to the horizontal position.



M29529

4. If blade is not balanced, heavy end will drop.

5. Lightly grind bevel of the heavy end, WITHOUT changing the original angle of blade.

6. Recheck balance.

7. Adjust balancer track (B) to just touch blade tip.

8. Turn blade to opposite tip.

9. Blade should also touch in same way.

IMPORTANT: Avoid damage! Install new blade if difference between blade tips and balancer track measures over 1.5 mm (0.059 in.) (C).

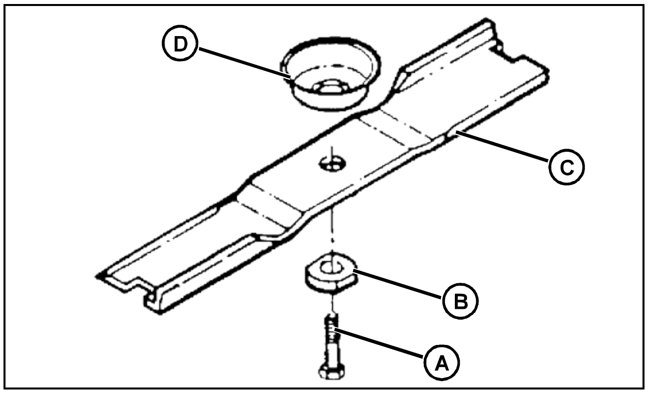
42-Inch Deck Mower Blades

Removal:

CAUTION: Avoid injury! ROTATING BLADES/ MOVING PARTS. STOP engine. Remove ignition key. Wait for all moving parts to STOP.

1. Remove mower deck.

CAUTION: Avoid injury! SHARP EDGES. Wear gloves or wrap blade with a shop towel when removing/installing blades to minimize the risk of personal injury. DO NOT hold blade with bare hands.



M74256

2. Remove cap screw (A), washer (B), blade (C), and cup (D).

3. Inspect blade for cracks, wear or damage. Replace if needed.

4. Sharpen and balance as needed.

Installation:

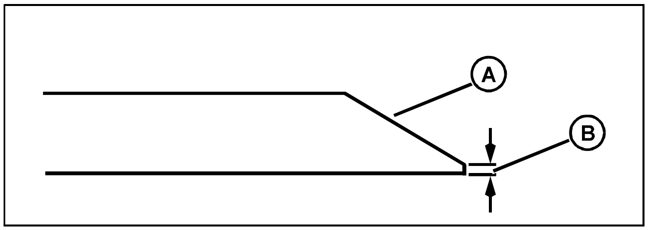
Installation is the reverse of removal.

IMPORTANT: Avoid damage! Make sure deflector cup is in place between spindle and blades, and that the concave side of washer faces the blade.

- Install blade with bent tips up.
- Tighten cap screw to 74 N•m (55 lb-ft).

Sharpen Blades:

1. Sharpen blades using grinder, file or power sharpener.



MIF

2. Do not alter original bevel (A). Blade should have 0.40 mm (0.016 in.) cutting edge (B) rather than a razor-type edge to prevent excessive chipping of the cutting edge.

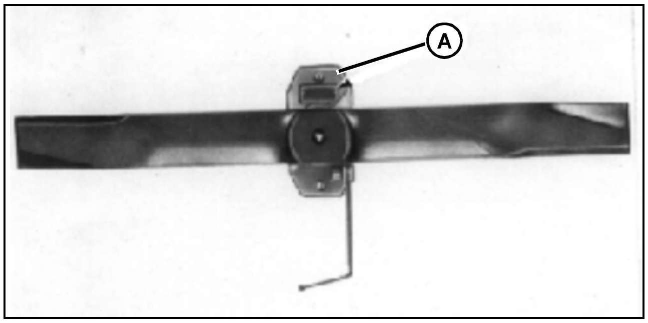
NOTE: If excessive browning of ends of mown grass occurs or if mower is to be used on tough grasses it may be necessary to grind the blade to a sharp edge.

3. Balance blades. See “Balance Blades” below.

Balance Blades:

CAUTION: Avoid injury! SHARP EDGES. Wear gloves or wrap blade with a shop towel when handling blades to minimize the risk of personal injury. DO NOT hold blade with bare hands.

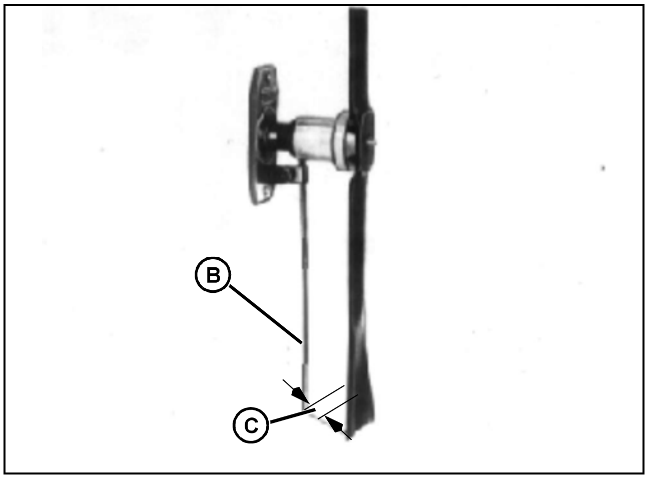
1. If needed, sharpen blade. See “Sharpen Blades” above.
2. Clean blade and remove any accumulated grass/dirt with scraper or wire brush and wipe blade clean.



M29527

3. Set blade on JT07076 Rotary Blade Balancer (A) and turn blade to the horizontal position.

IMPORTANT: Avoid damage! Install new blade if difference between blade tips and balancer track measures over 1.5 mm (0.059 in.) (C).



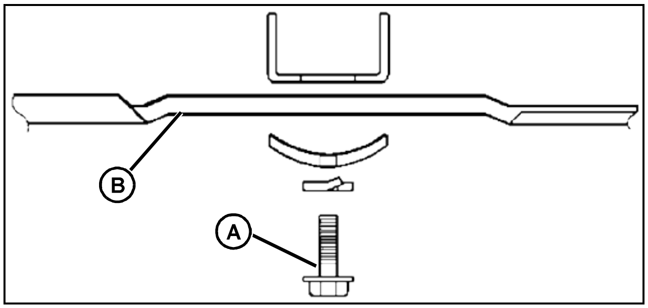
M29528

4. If blade is not balanced, heavy end will drop.
5. Lightly grind bevel of the heavy end, WITHOUT changing the original angle of blade.
6. Recheck balance.
7. Adjust balancer track (B) to just touch blade tip.
8. Turn blade to opposite tip.
9. Blade should also touch in same way.

42-Inch Mulching Blade Removal and Installation

Procedure:

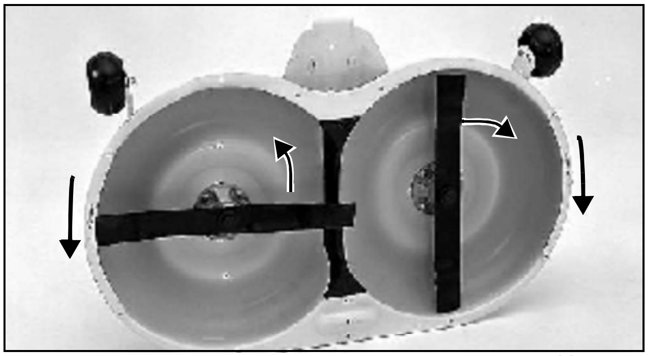
1. Remove mower deck.



M88112G

2. Hold mower blade with glove to prevent spindle from spinning,
3. Remove cap screw with washer (A) and blade (B).
4. Inspect blades; sharpen/balance or replace as necessary.

NOTE: The right and left sides are marked on the rear draft brackets of the machine. There are direction marks on the outside edge of the mower. The blades are also marked for identification.



M88618

5. Using gloves, position mower blade (B) with the cutting edge toward the ground onto the mower spindle, and align key on bottom of spindle with slot in blade.
6. Install and tighten capscrew (A) by hand until mower blade is in full contact (fully seated) with spindle.
7. Hold mower blade with glove to prevent spinning, and tighten capscrew to specification.
8. Ensure blade timing is correct. Blades should be indexed 90° ± 10° apart; if not, see “Timing Belt Adjustment - 42-Inch Mulching Deck” on page 542.
9. Install mower deck.

Specifications:

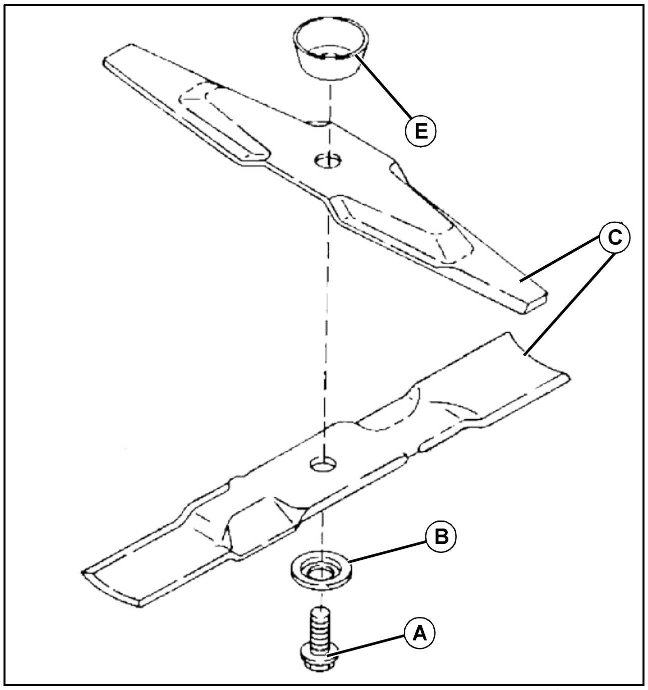
Blade cap screw .... 62 N•m (46 lb-ft)

44-Inch Deck Mower Blades

Removal:

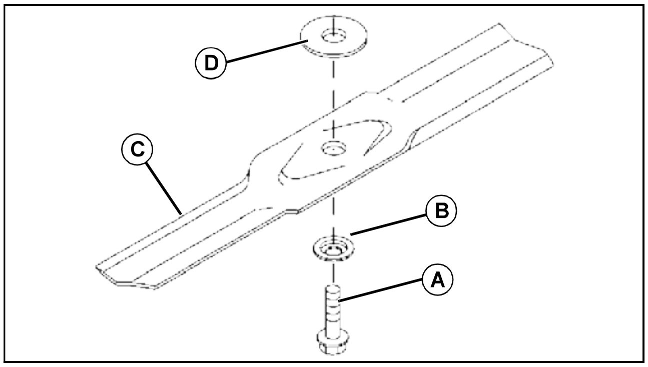
1. Remove mower deck.

CAUTION: Avoid injury! SHARP EDGES. Wear gloves or wrap blade with a shop towel when removing/installing blades to minimize the risk of personal injury. DO NOT hold blade with bare hands.



M82739A

Picture Note: Mulching Configuration



M99534

Picture Note: Rear Discharge Configuration

2. Remove cap screw (A), washer (B), blade(s) (C), spacer (D) (if equipped), and cup (E).

3. Inspect blade(s) for cracks, wear or damage. Replace if needed.

4. Sharpen and balance as needed.

Installation:

Installation is the reverse of removal.

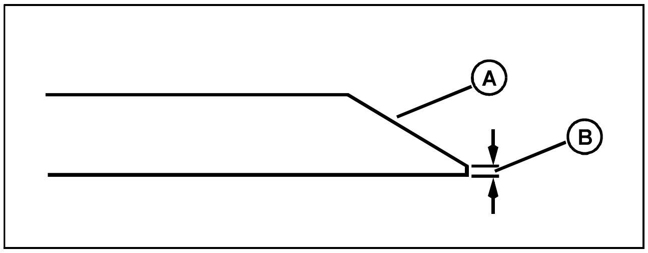
IMPORTANT: Avoid damage! Make sure deflector cup is in place between spindle and blades, and that the concave side of washer faces the blade.

- Install blade with bent tips up.
- Tighten cap screw to 68 N•m (50 lb-ft).

Sharpen Blades:

CAUTION: Avoid injury! FLYING SPARKS/ METAL FRAGMENTS, SHARP EDGES. Wear approved eye protection and gloves when sharpening blades to minimize the risk of personal injury.

1. Sharpen blades using grinder, file or power sharpener.



MIF

2. Do not alter original bevel (A). Blade should have 0.40 mm (0.016 in.) cutting edge (B) rather than a razor-type edge to prevent excessive chipping of the cutting edge.

NOTE: If excessive browning of ends of mown grass occurs or if mower is to be used on tough grasses it may be necessary to grind the blade to a sharp edge.

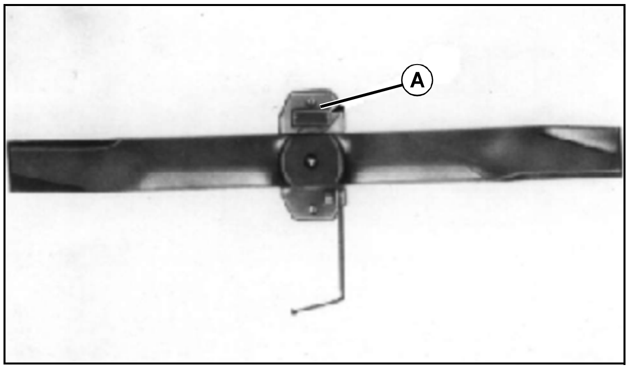
3. Balance blades.

Balance Blades:

CAUTION: Avoid injury! SHARP EDGES. Wear gloves or wrap blade with a shop towel when handling blades. DO NOT hold blade with bare hands.

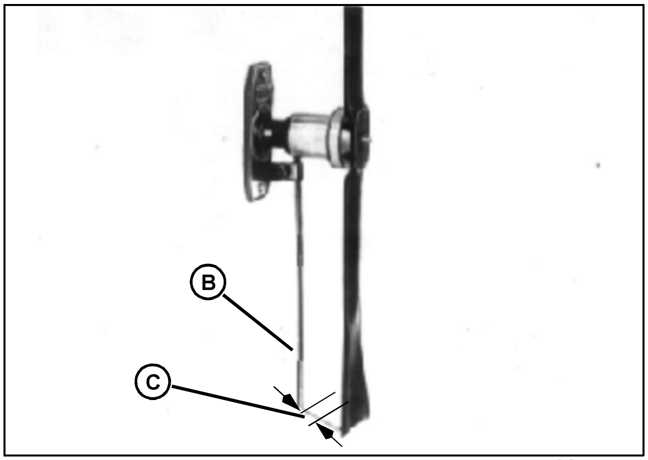
1. Sharpen blade, if required. See “Sharpen Blades” above.

2. Clean blade and remove any accumulated grass/dirt with scraper or wire brush and wipe blade clean.



M29527

3. Set blade on JT07076 Rotary Blade Balancer (A) and turn blade to the horizontal position.



M29528

4. If blade is not balanced, heavy end will drop.

5. Lightly grind bevel of the heavy end, WITHOUT changing the original angle of blade.

6. Recheck balance.

IMPORTANT: Avoid damage! Install new blade if difference between blade tips and balancer track measures over 1.5 mm (0.059 in.) (C).

7. Adjust balancer track (B) to just touch blade tip.

8. Turn blade to opposite tip.

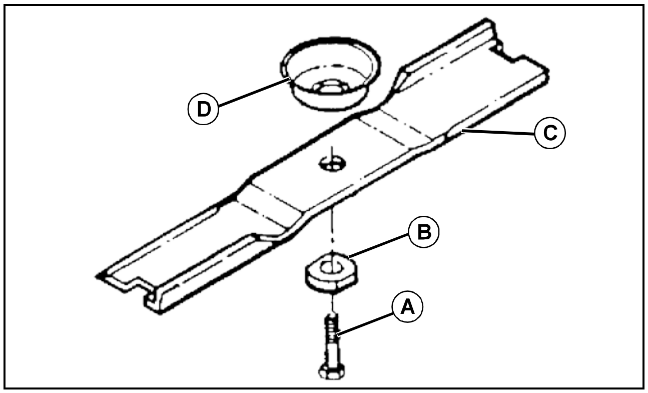
9. Blade should also touch in same way.

48-Inch Deck Mower Blades

Removal:

1. Remove mower deck.

CAUTION: Avoid injury! Blades are sharp and could cause personal injury. Wear gloves or wrap blade with rag when removing/installing blades. DO NOT hold blade with bare hands.



M74256

2. Remove cap screw (A), washer (B), blade (C), and cup (D).

3. Inspect blade for cracks, wear or damage. Replace blade if needed.

4. Sharpen and balance as needed.

Installation:

Installation is the reverse of removal.

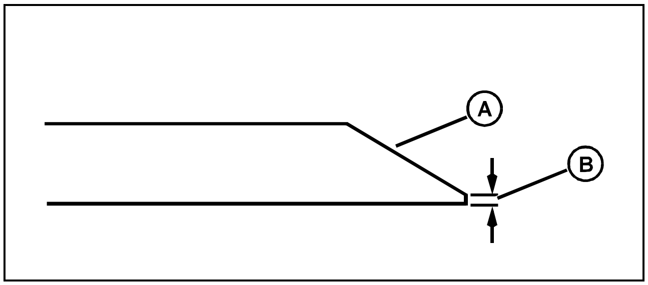
IMPORTANT: Avoid damage! Make sure deflector cup is in place between spindle and blades, and that the concave side of washer faces the blade.

- Install blade with bent tips up.
- Tighten cap screw to 68 N•m (50 lb-ft).

Sharpen:

CAUTION: Avoid injury! FLYING SPARKS/ METAL FRAGMENTS, SHARP EDGES. Wear approved eye protection and gloves when sharpening blades to minimize the risk of personal injury.

1. Sharpen blades using grinder, file or power sharpener.



MIF

2. Do not alter original bevel (A). Blade should have 0.40 mm (0.016 in.) cutting edge (B) rather than a razor-type edge to prevent excessive chipping of the cutting edge.

NOTE: If excessive browning of ends of mown grass occurs or if mower is to be used on tough grasses it may be necessary to grind the blade to a sharp edge.

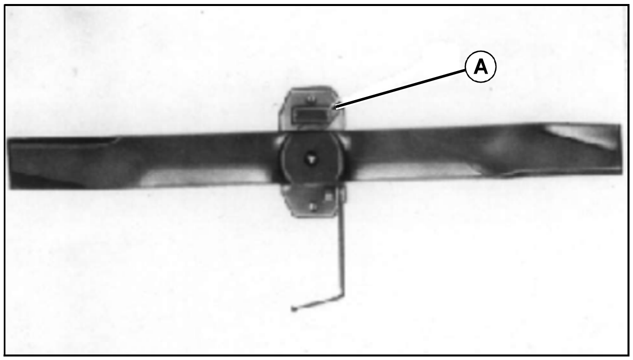
3. Balance blades.

Balance:

CAUTION: Avoid injury! Blades are sharp and could cause personal injury. Wear gloves or wrap blade with rag when handling blades. DO NOT hold blade with bare hands.

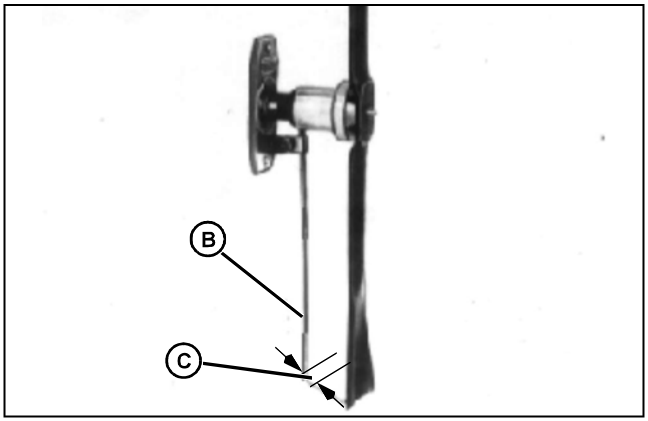
1. Sharpen blade, if required.

2. Clean blade and remove any accumulated grass/dirt with scraper or wire brush and wipe blade clean.



M29527

3. Set blade on JT07076 Rotary Blade Balancer (A) and turn blade to the horizontal position.



M29528

4. If blade is not balanced, heavy end will drop.

5. Lightly grind bevel of the heavy end, WITHOUT changing the original angle of blade.

6. Recheck balance.

7. Adjust balancer track (B) to just touch blade tip.

8. Turn blade to opposite tip.

9. Blade should also touch in same way.

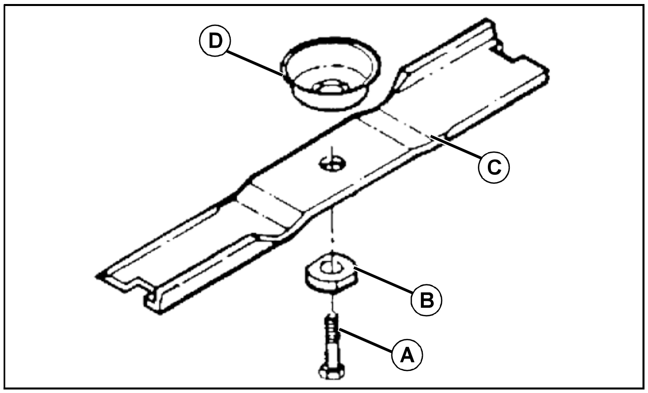
IMPORTANT: Avoid damage! Install new blade if difference between blade tips and balancer track measures over 1.5 mm (0.059 in.) (C).

54-Inch Deck Mower Blades

Removal and Installation:

CAUTION: Avoid injury! ROTATING BLADES/ MOVING PARTS. STOP engine. Remove ignition key. Wait for all moving parts to STOP.

1. Remove mower deck.



M74256

2. Remove cap screw (A), washer (B), and blade (C).

3. Inspect blade for cracks, wear or damage. Replace blade if needed.

4. Sharpen and balance as needed.

Installation is the reverse of removal.

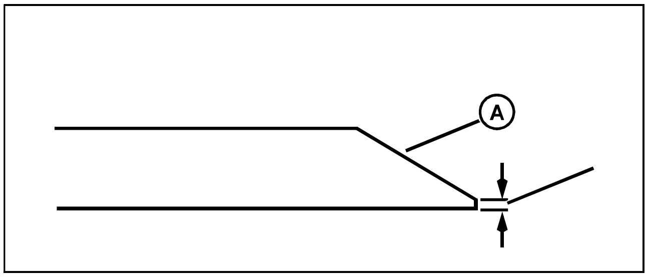
IMPORTANT: Avoid damage! Make sure deflector cup (D) is in place between spindle and blade.

- Install blade with bent tips up.
- Tighten cap screw to 68 N•m (50 lb-ft).

Sharpen:

CAUTION: Avoid injury! FLYING SPARKS/ METAL FRAGMENTS, SHARP EDGES. Wear approved eye protection and gloves when sharpening blades to minimize the risk of personal injury.

1. Sharpen blades using grinder, file or power sharpener.



MIF

2. Do not alter original bevel (A). Blade should have 0.40 mm (0.016 in.) cutting edge (B) rather than a razor-type edge to prevent excessive chipping of the cutting edge.

NOTE: If excessive browning of ends of mown grass occurs or if mower is to be used on tough grasses it may be necessary to grind the blade to a sharp edge.

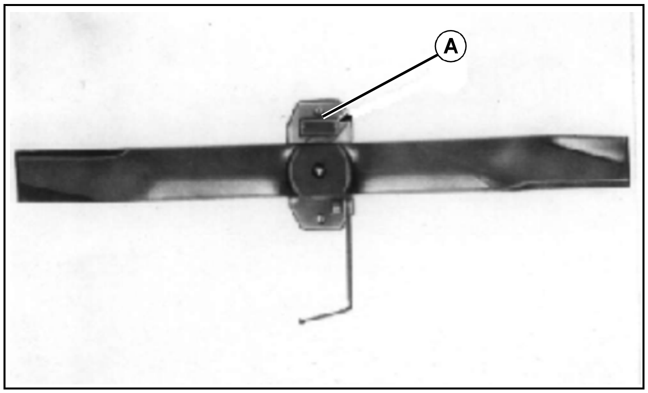
3. Balance blades.

Balance:

CAUTION: Avoid injury! Wear gloves or wrap blade with a shop towel when handling blades to minimize the risk of personal injury. DO NOT hold blade with bare hands.

1. Sharpen blade, if required.

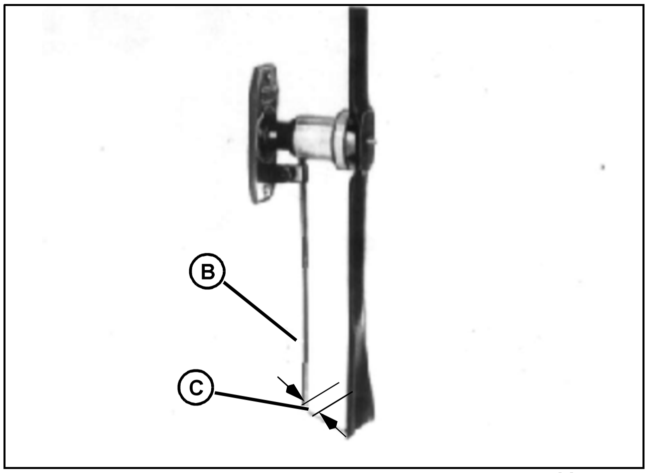
2. Clean blade and remove any accumulated grass/dirt with scraper or wire brush and wipe blade clean.



M29527

3. Set blade on JT07076 Rotary Blade Balancer (A) and turn blade to the horizontal position.

IMPORTANT: Avoid damage! Install new blade if difference between blade tips and balancer track measures over 1.5 mm (0.059 in.) (C).



M29528

4. If blade is not balanced, heavy end will drop.

5. Lightly grind bevel of the heavy end, WITHOUT changing the original angle of blade.

6. Recheck balance.

7. Adjust balancer track (B) to just touch blade tip.

8. Turn blade to opposite tip.

9. Blade should also touch in same way.

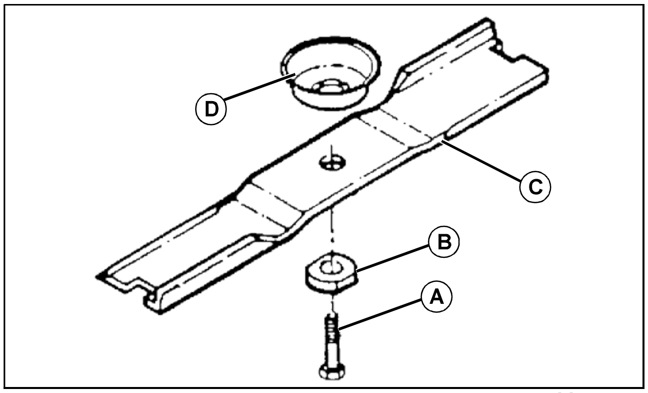
54-Inch Convertible Deck Mower Blades

CAUTION: Avoid injury! ROTATING BLADES/ MOVING PARTS. STOP engine. Remove ignition key. Wait for all moving parts to STOP.

Removal and Installation:

1. Remove mower deck.

CAUTION: Avoid injury! SHARP EDGES. Wear gloves or wrap blade with a shop towel when handling blades to minimize the risk of personal injury. DO NOT hold blade with bare hands.



M74256

2. Remove cap screw (A), washer (B), and blade (C).

3. Inspect blade for cracks, wear or damage. Replace blade if needed.

4. Sharpen and balance as needed.

Installation is the reverse of removal.

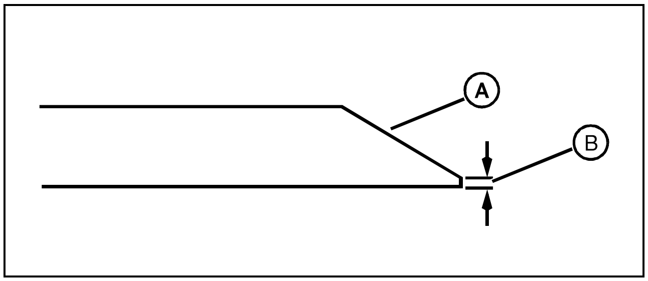
IMPORTANT: Avoid damage! Make sure deflector cup (D) is in place between spindle and blade.

- Install blade with bent tips up.
- Tighten cap screw to 68 N•m (50 lb-ft).

Sharpen:

CAUTION: Avoid injury! FLYING SPARKS/ METAL FRAGMENTS, SHARP EDGES. Wear approved eye protection and gloves when sharpening blades to minimize the risk of personal injury.

1. Sharpen blades using grinder, file or power sharpener.



MIF

2. Do not alter original bevel (A). Blade should have 0.40 mm (0.016 in.) cutting edge (B) rather than a razor-type edge to prevent excessive chipping of the cutting edge.

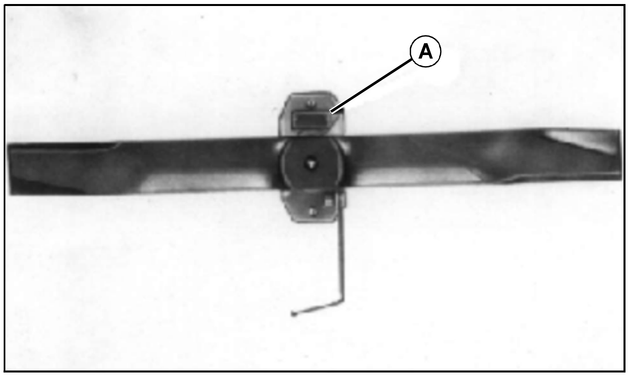
NOTE: If excessive browning of ends of mown grass occurs or if mower is to be used on tough grasses it may be necessary to grind the blade to a sharp edge.

3. Balance blades.

Balance:

1. Sharpen blade, if required.

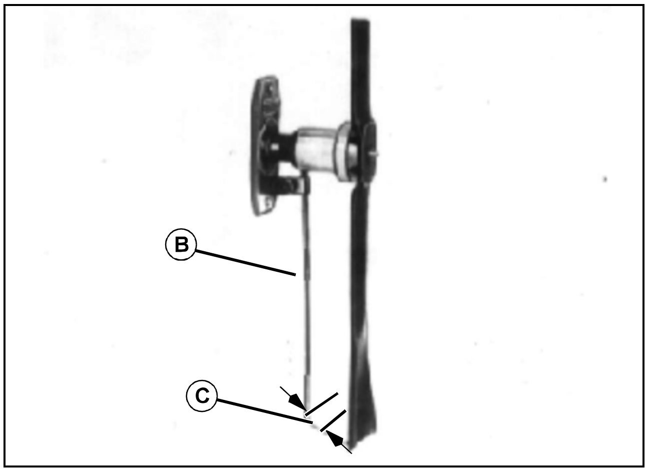
2. Clean blade and remove any accumulated grass/dirt with scraper or wire brush and wipe blade clean.



M29527

3. Set blade on JT07076 Rotary Blade Balancer (A) and turn blade to the horizontal position.

IMPORTANT: Avoid damage! Install new blade if difference between blade tips and balancer track measures over 1.5 mm (0.059 in.) (C).



M29528

4. If blade is not balanced, heavy end will drop.

5. Lightly grind bevel of the heavy end, WITHOUT changing the original angle of blade.

6. Recheck balance.

IMPORTANT: Avoid damage! Install new blade if difference between blade tips and balancer track measures over 1.5 mm (0.059 in.) (C).

7. Adjust balancer track (B) to just touch blade tip.

8. Turn blade to opposite tip.

9. Blade should also touch in same way.

38-Inch Deck Spindles

Removal:

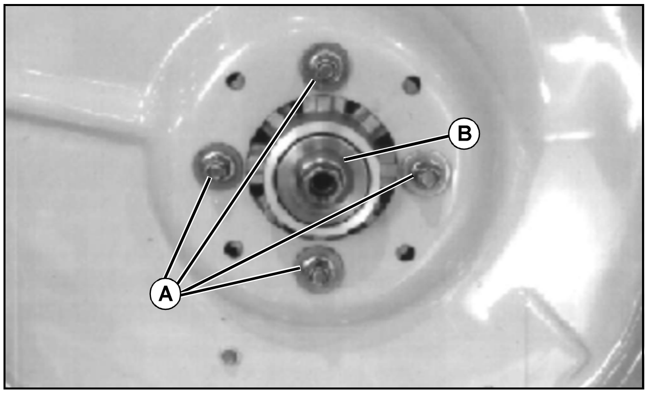
1. Remove mower deck.

2. Remove mower drive belt.

IMPORTANT: Avoid damage! SHARP EDGES. Wear gloves or wrap blade with a shop towel when removing/installing blades to minimize the risk of personal injury. DO NOT hold blade with bare hands.

3. Remove cap screw, washer, and mower blade.

NOTE: If only the nut, spindle sheave, or fan need to be replaced, use a block of wood to prevent the blade from turning. Remove nut, sheave, and fan. Replace parts as needed.



M54873

4. Remove four nuts, washers (A) and spindle (B).

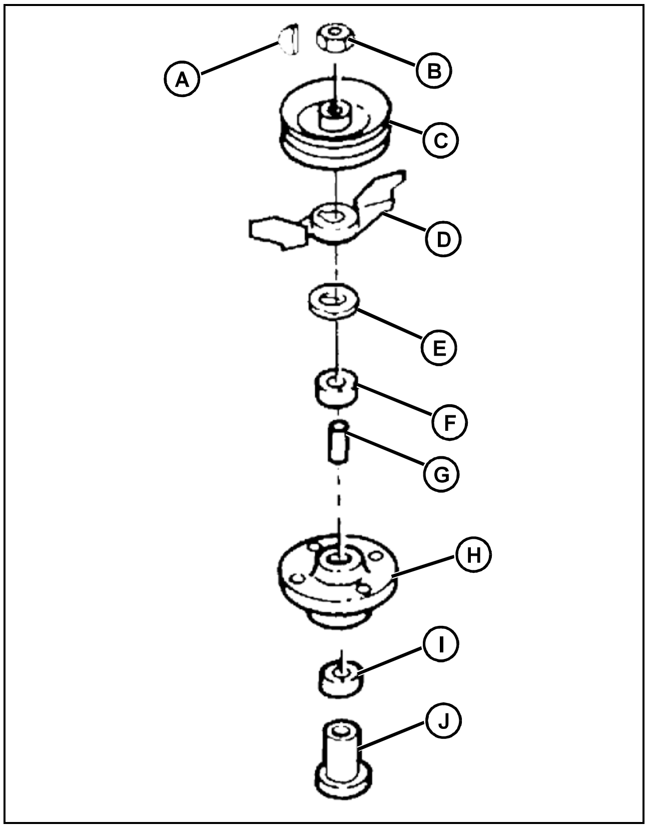
5. Inspect spindle for smooth operation, wear, or damage. Disassemble and replace parts, or replace entire spindle assembly as needed.

Installation:

Installation is the reverse of removal.

- Tighten mounting nuts to 26 N•m (230 lb-in.).

Disassembly:



M99520

A - Key
B - Nut
C - Sheave

D - Fan
E - Washer
F - Ball Bearing
G - Spacer
H - Housing
I - Ball Bearing
J - Shaft

1. Install blade and washer to spindle. Secure with cap screw.

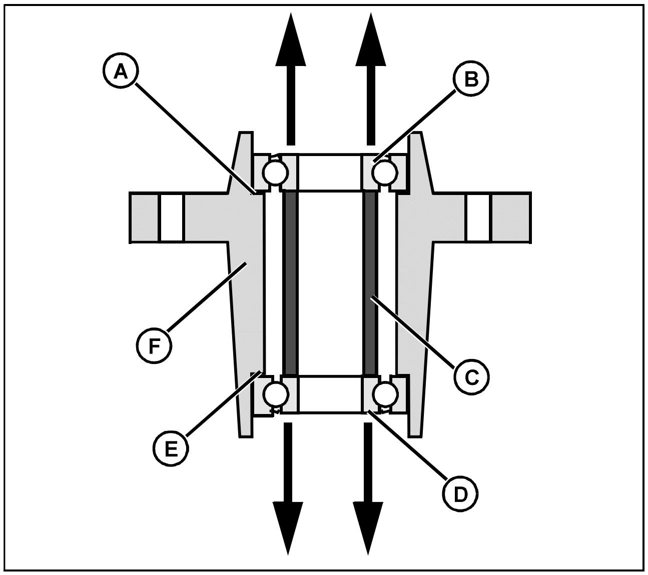
2. Secure the spindle assembly by the blade in a soft jaw vise.

3. Remove nut, sheave, key, fan, and washer.

4. Remove cap screw, washer, and blade.

5. Remove shaft from housing using a press, or suitable driver and mallet.

NOTE: Bearings are seated against shoulder in housing, and must be removed one at a time, from either side of the housing.
Remove bearings only if replacement is necessary.



MIF

A - Shoulder
B - Upper Bearing
C - Spacer
D - Lower Bearing
E - Shoulder
F - Housing

6. Remove one bearing using a suitable puller, or pin punch and hammer.

7. Remove spacer.

8. Remove second bearing using a press, or suitable driver and a mallet.

9. Inspect all parts for wear or damage. Replace parts as needed.

Assembly:

1. Using a press or a suitable driver and a soft-faced mallet, install upper bearing tight against spindle hub shoulder.

2. Install spacer.

3. Using a press or a suitable driver and a soft-faced mallet, install lower bearing tight against spindle hub shoulder.

4. Install spindle shaft.

IMPORTANT: Avoid damage! When installing spindle sheave nut, DO NOT hold end of spindle shaft in a vise. End of the spindle shaft will be damaged, resulting in improper blade operation.

5. Install blade, washer, and cap screw onto spindle shaft. Make sure that the concave side of washer faces the blade.

6. Hold the blade with a soft jaw vise or, if spindle is in the mower deck, with a block of wood. Install fan, spindle sheave, and nut. Tighten nut to 140 N•m (103 lb-ft).

7. Remove cap screw, washer, and blade.

8. Lubricate spindle with multipurpose EP-2 grease or equivalent at lubrication fitting.

42-Inch Deck Spindles

Removal:

⚠ **CAUTION: Avoid injury! ROTATING BLADES/ MOVING PARTS. STOP engine. Remove ignition key. Wait for all moving parts to STOP.**

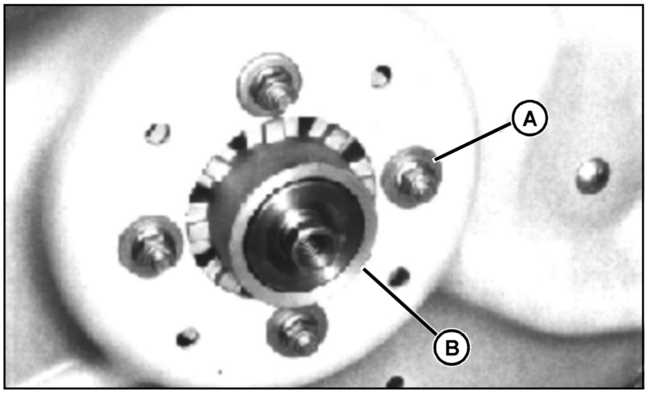
1. Remove mower deck.

⚠ **CAUTION: Avoid injury! SHARP EDGES. Wear gloves or wrap blade with a shop towel when removing/installing blades to minimize the risk of personal injury. DO NOT hold blade with bare hands.**

2. Remove mower blade.

3. Remove mower drive belt.

NOTE: If only the nut or spindle sheave need to be replaced, use a block of wood to prevent the blade from turning. Remove nut and sheave, and replace parts as needed.



M54685

4. Remove four nuts and washers (A), and spindle (B).

5. Check spindle for smooth bearing operation, wear, or damage. Repair or replace components as needed.

Installation:

Installation is the reverse of removal.

- Tighten spindle retaining nuts to 26 N•m (230 lb-in.).
- When installing blade, make sure concave side of blade washer faces blade.
- Tighten blade cap screw to 73 N•m (54 lb-ft).

Disassembly and Inspection:

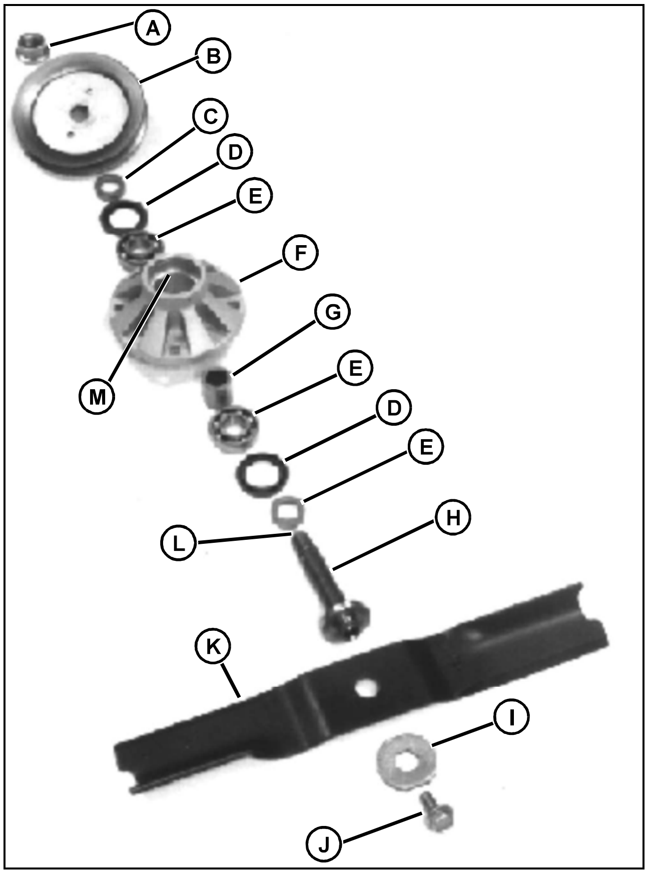
IMPORTANT: Avoid damage! When removing spindle sheave nut, DO NOT hold end of spindle shaft in a vise. Spindle shaft will be damaged, resulting in improper blade operation.

1. Remove spindle from deck. See “Removal:” on page 566.

CAUTION: Avoid injury! SHARP EDGES. Wear gloves or wrap blade with a shop towel when removing/installing blades to minimize the risk of personal injury. DO NOT hold blade with bare hands.

2. Install blade and washer to spindle. Secure with cap screw.

3. Secure the spindle assembly by the blade in a soft jaw vise.



M44948

A - Nut
B - Sheave
C - Seal Ring
D - Seal
E - Bearing
F - Housing
G - Spacer
H - Spindle Shaft
I - Washer
J - Cap Screw
K - Blade
L - Lubrication Fitting
M - Shoulder in housing

4. Remove nut, sheave, and lubrication fitting.

5. Remove cap screw, washer, and blade.

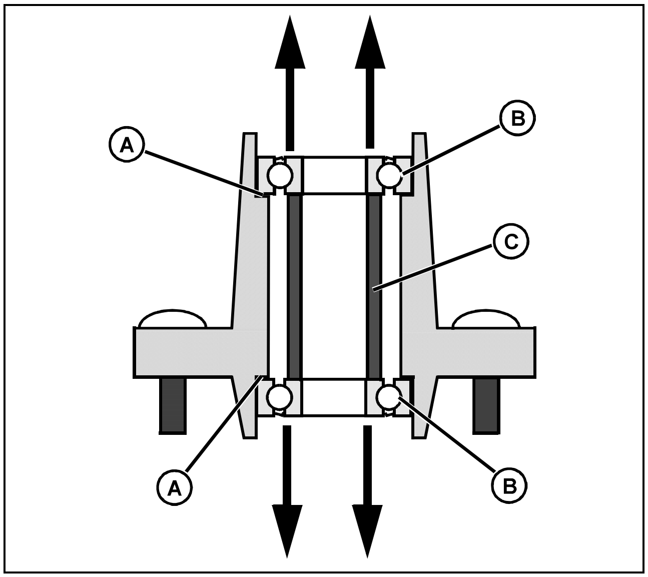
6. Using a suitable puller or press, remove spindle shaft from housing.

7. Note location of notched side, and remove two seal rings.

IMPORTANT: Avoid damage! Bearings are seated against shoulder in housing, and cannot be removed with a press. Remove bearings only if replacement is necessary.

8. Remove seals using a suitable seal puller.

NOTE: Bearings are seated against shoulder (A) in housing, and must be removed one at a time, from either side of the housing.
Remove bearings only if replacement is necessary.



MIF

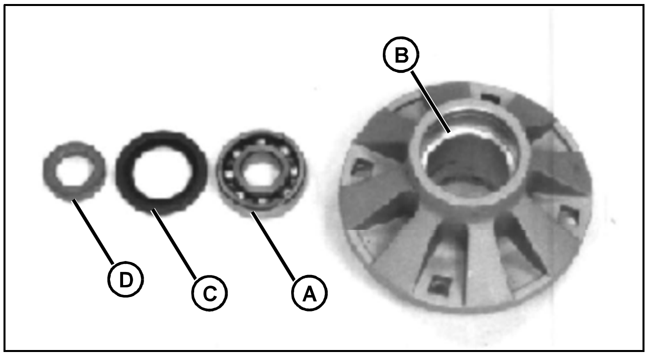
9. Remove one bearing (B) using a suitable puller, or pin punch and hammer.

10.Remove spacer (C).

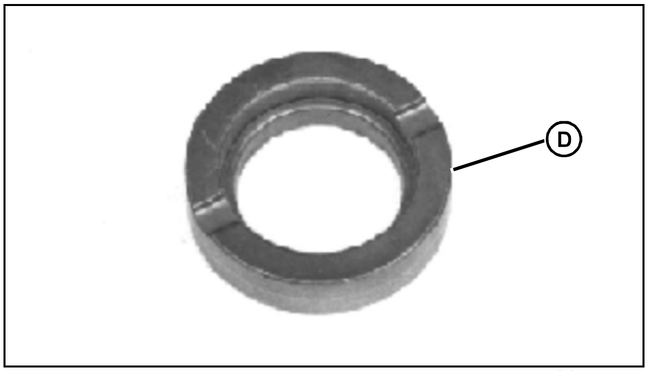
11.Remove second bearing using a press, or suitable driver and a mallet.

12.Inspect all parts for wear or damage. Replace parts as needed.

Assembly:



M44949



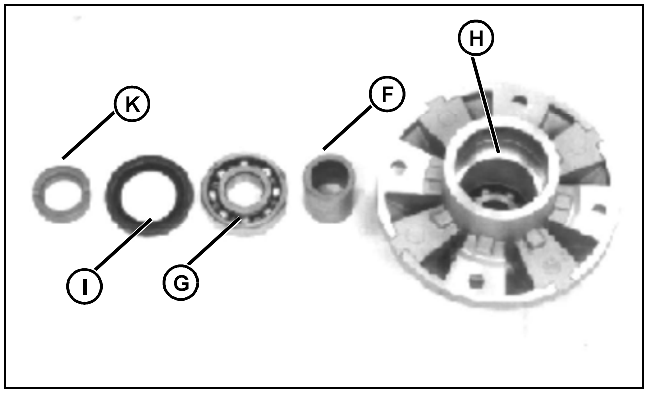
M44950

1. Using a press or a suitable driver and a soft-faced mallet, install upper bearing (A) tight against spindle hub shoulder (B).

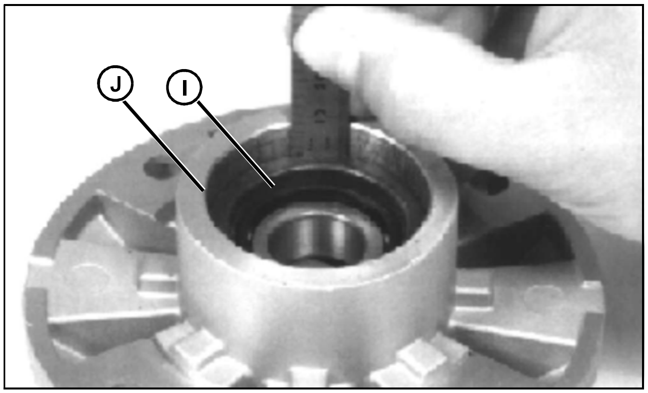
NOTE: Install upper seal (C) with lip toward bearing.

2. Using a press or a suitable seal driver and a soft-faced mallet, install upper seal (C) tight against bearing.

3. Install upper seal ring (D) inside seal lip with grease notch (E) toward bearing.



M44951



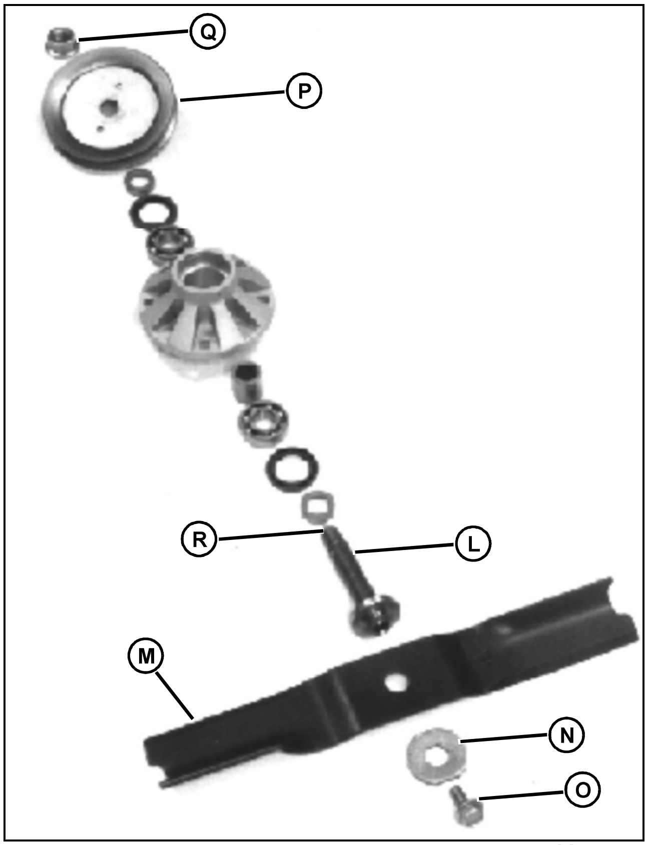
M44952

4. Install spacer (F).

5. Install lower bearing (G) in hub using a press, just enough so the lower seal can be installed.

6. Install lower seal (I) with lip toward bearing using a press, until seal is 7.3 mm (0.29 in.) below hub flange (J).

7. Install lower seal ring (K) inside seal lip with grease notch away from bearing.



M44948

8. Install spindle shaft (L).

IMPORTANT: Avoid damage! When installing spindle sheave nut, DO NOT hold end of spindle shaft in a vise. Spindle shaft will be damaged, resulting in improper blade operation.

9. Install blade (M), washer (N), and cap screw (O) onto spindle shaft. Make sure that the concave side of washer faces the blade.

10.Hold the blade with a soft jaw vise or, if spindle is in the mower deck, with a block of wood. Install spindle sheave (P), nut (Q), and lubrication fitting (R). Tighten nut to 127 N•m (94 lb-ft).

11.Remove cap screw, washer, and blade.

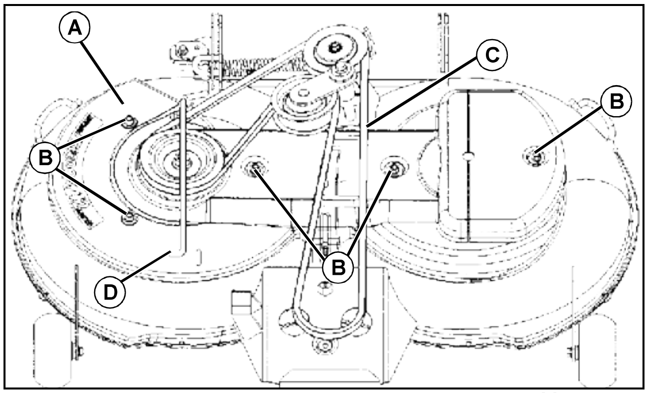
12.Lubricate spindle with EP-2 grease or equivalent at lubrication fitting.

42-inch Mulching Deck Spindle and Bearing Replacement

Procedure:

1. Remove mower deck.

2. Remove mower blade.

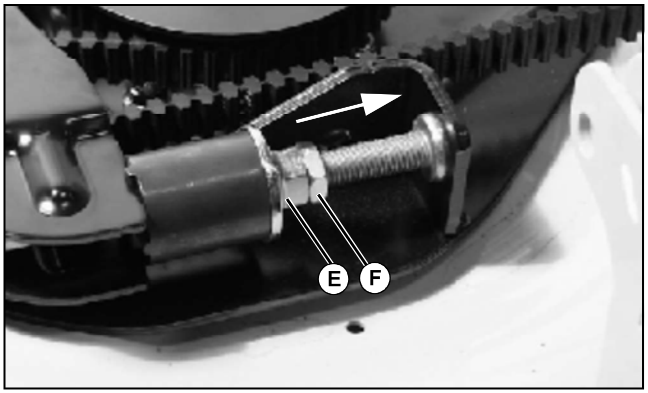


MX8412A

3. Remove mower drive belt (C).

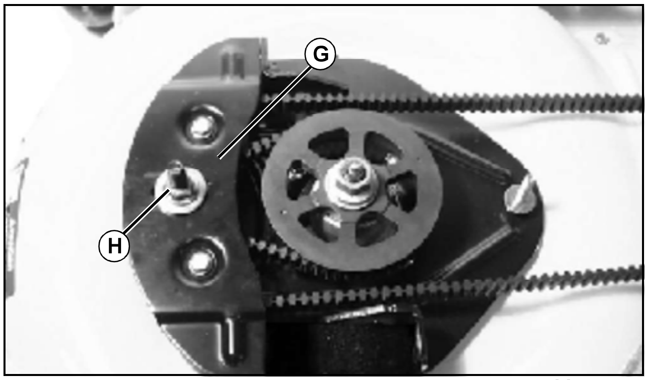
4. Move mower engagement rod assembly (D) back to clear timing belt cover.

5. Remove five flange locknuts (B) and cover (A).



MX1376

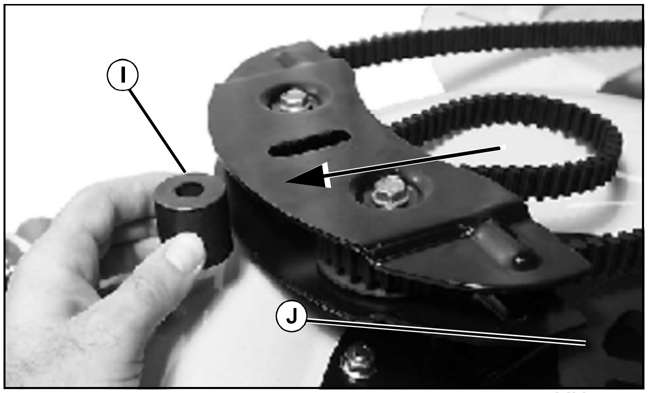
6. Turn jam nut (F) and adjusting nut (E) counterclockwise to end of threaded rod, and remove tensioning spring assembly.



MX1377

7. For the right side of deck, remove center nut and washer (H) and move fixed idler assembly (G) close to the spindle sprocket. DO NOT loosen other idle assembly hardware.

8. Raise idler assembly upward as you carefully remove timing belt from the left spindle sprocket.



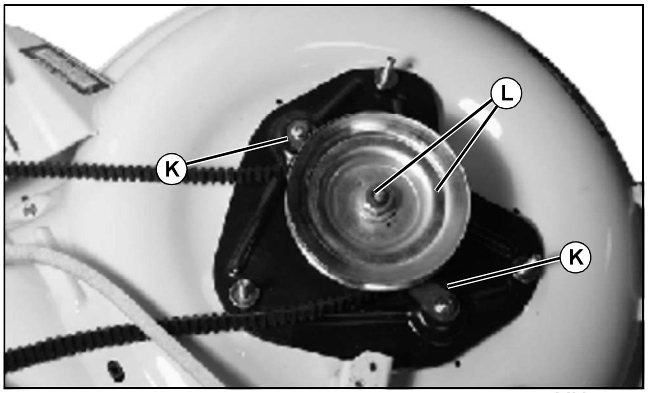
MX1378

9. Remove spacer (I) located between fixed idler assembly plates and carefully pull belt from assembly.

10.Support blade for right hand spindle.

11.Remove nut and washer, and timing sprocket (J).

12.Remove four nuts securing spindle assembly to deck.



MX1379

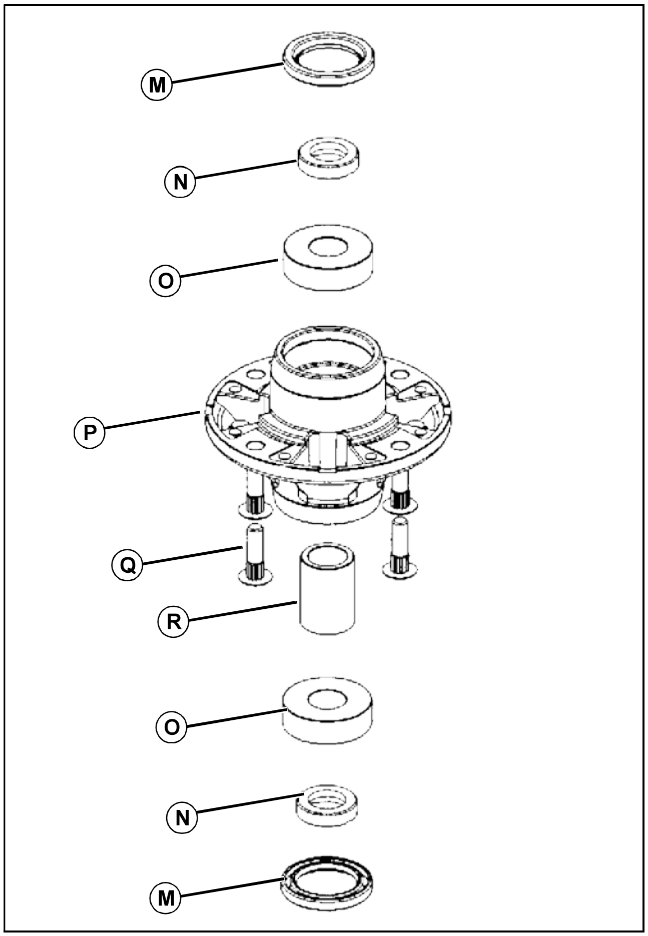
13.For the left side of the deck, loosen two belt guides (K) and rotate away from left sprocket.

14.Remove timing belt.

15.Support blade for left hand spindle.

16.Remove nut and sheave (L).

17.Remove four nuts securing spindle assembly to deck.



M89135

18.Remove both seal bushings (M).

19.Use a screwdriver to push the spacer (R) to one side, and use a drift punch and a hammer to tap out the bearings (O) and seal bushings (N) evenly.

20.Clean spindle housing (P) with a suitable solvent, and inspect housing for damage.

21.Fill spindle cavity, and pack new bearings with GREASE-GARD® or equivalent.

22.Press upper bearing in against shoulder first.

23.Install spacer, and press in bottom bearing.

24.Lubricate seal lips with grease. Install seals with seal lips facing bearings.

25.Install seal bushings ensuring notch is down.

26.Align inside diameter of all components to allow spindle shaft installation.

IMPORTANT: Avoid damage! If the threads on a mounting stud (Q) have been damaged, it can be replaced with a nut and bolt. Ensure that the area around the stud to be pressed out is supported from underneath to prevent the spindle mounting flange from being damaged.

27. Position spindle into deck from the bottom and attach with four nuts; tighten to 27 N•m (20 lb-ft).

28. Replace timing sprocket (J) and secure with washer and nut. Tighten nut to 145 N•m (107 lb-ft). Align timing marks to blade.

44-Inch Deck Spindles

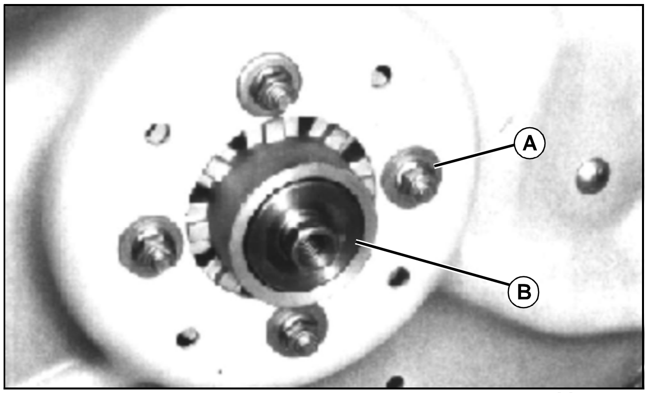
Removal:

CAUTION: Avoid injury! ROTATING BLADES/ MOVING PARTS. STOP engine. Remove ignition key. Wait for all moving parts to STOP.

1. Remove mower deck,
2. Remove mower drive belt.

CAUTION: Avoid injury! SHARP EDGES. Wear gloves or wrap blade with a shop towel when removing/installing blades to minimize the risk of personal injury. DO NOT hold blade with bare hands.

3. Remove mower blade(s).



M54685

4. Remove four nuts and washers (A) and spindle (B).
5. Check spindle for smooth bearing operation, wear, or damage. Repair or replace components as needed. See "Disassembly and Inspection:" on page 571.

Installation:

Installation is the reverse of removal.

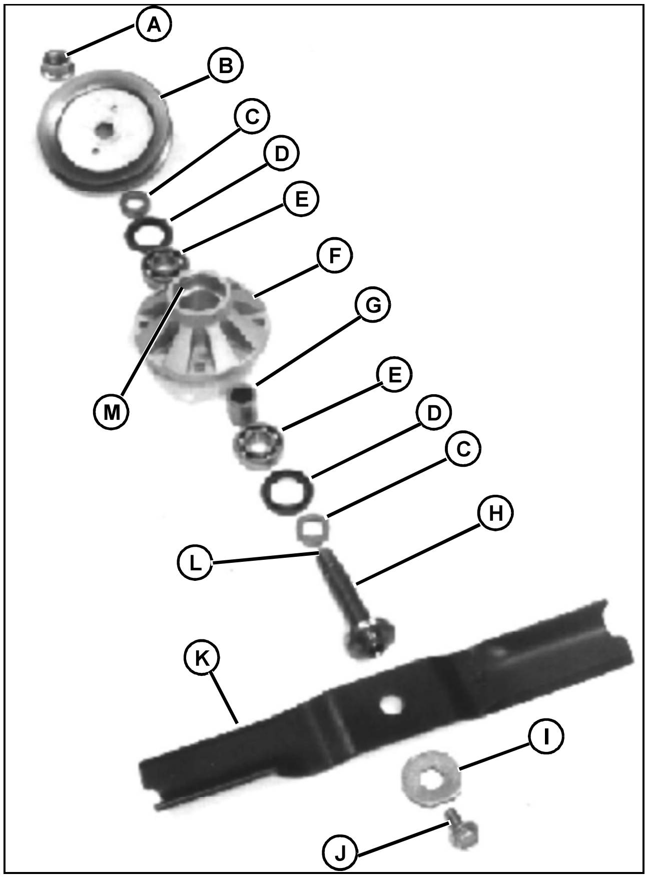
1. Tighten spindle retaining nuts to 26 N•m (230 lb-in.).
2. When installing blade, make sure concave side of blade washer faces blade.
3. Tighten blade cap screw to 122 N•m (90 lb-ft).

Disassembly and Inspection:

IMPORTANT: Avoid damage! When removing spindle sheave nut, DO NOT hold hex end of spindle shaft in a vise. Hex end of the spindle shaft will be damaged, resulting in improper blade operation.

NOTE: If only the nut or spindle sheave need to be replaced and the spindle is still in the deck, use a block of wood to prevent the blade from turning. Remove nut and sheave, and replace parts as needed.

1. Remove spindle from deck. See "Removal:" on page 571.
2. Install blade(s), and spacer (if equipped) to spindle. Secure the spindle by the blade in a soft jaw vise.



M44948

A - **Nut**
B - **Sheave**
C - **Seal Ring**
D - **Seal**
E - **Bearing**
F - **Housing**
G - **Spacer**
H - **Spindle Shaft**
I - **Washer**

J - Cap Screw
K - Blade
L - Lubrication Fitting
M - Shoulder in housing

3. Remove nut, sheave, and lubrication fitting.

NOTE: Two blade configurations are available:
Mulching - Two blades.
Rear Discharge - One blade and a spacer.
(Rear Discharge configuration shown.)

4. Remove cap screw and washer

5. (Rear Discharge Deck) Remove blade and spacer.

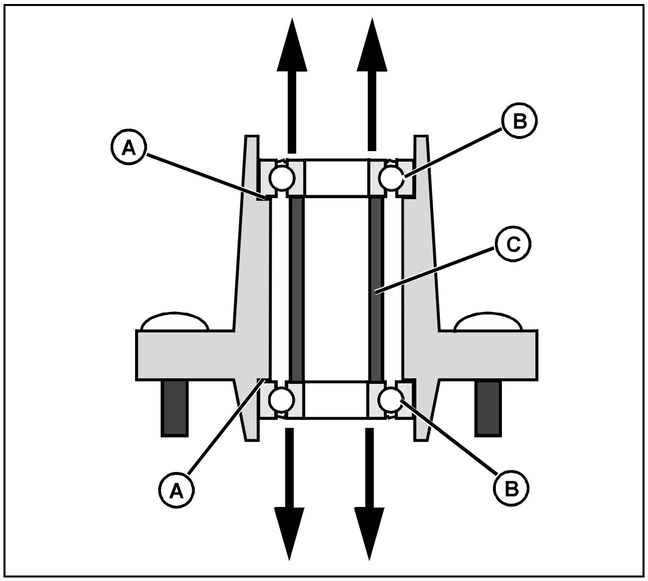
6. (Mulching Deck) Remove two blades.

7. Using a suitable puller or press, remove spindle shaft from housing.

8. Note location of notched side, and remove two seal rings.

9. Remove seals using a suitable seal puller, or screw-type puller.

NOTE: Bearings (A) are seated against shoulder (B) in housing, and must be removed one at a time, from either side of the housing.
Remove bearings only if replacement is necessary.



MIF

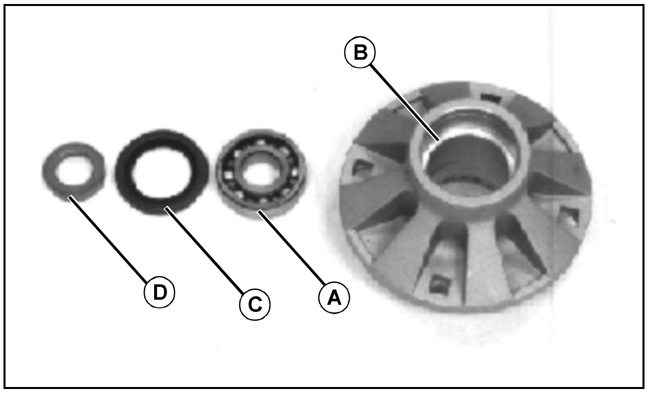
10.Remove one bearing (A) using a suitable puller, or pin punch and hammer.

11.Remove spacer (C).

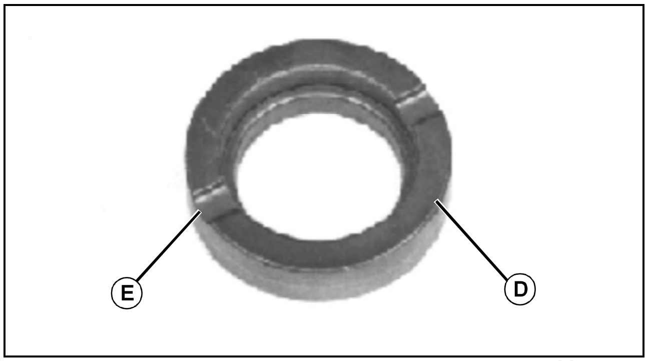
12.Remove second bearing using a press, or suitable driver and mallet.

13.Inspect all parts for wear or damage. Replace parts as needed.

Assembly:



M44949



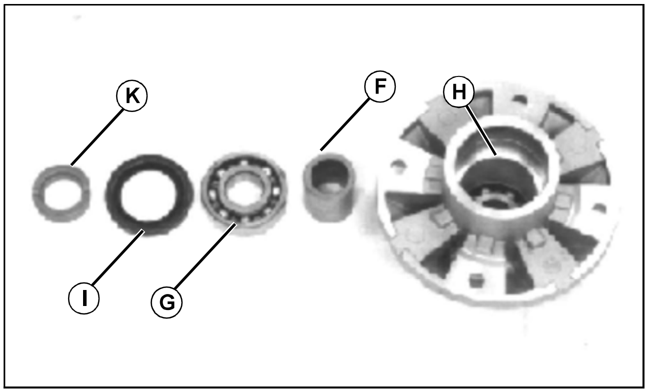
M44950

1. Using a press or a suitable seal driver and a soft-faced mallet, install upper bearing (A) tight against spindle hub shoulder (B).

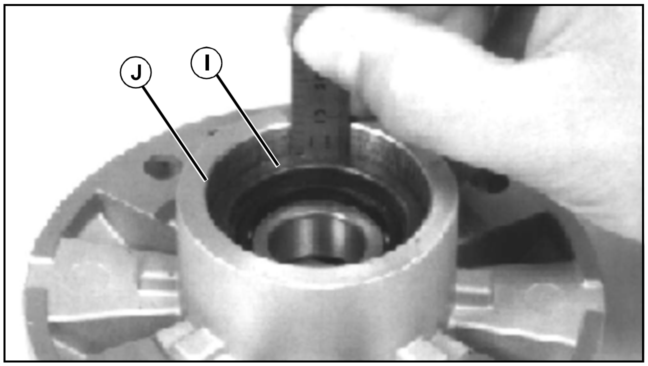
NOTE: Install upper seal with lip toward bearing.

2. Using a press or a suitable seal driver and a soft-faced mallet, install upper seal (C) tight against bearing.

3. Install upper seal ring (D) inside seal lip with grease notch (E) toward bearing.



M44951



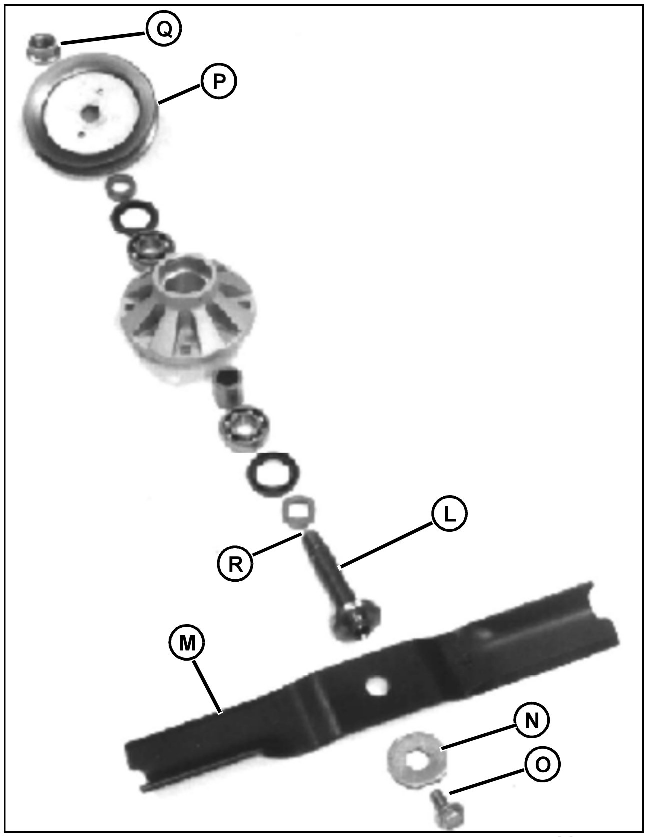
M44952

4. Install spacer (F).

5. Install lower bearing (G) in hub using a press, just enough so the lower seal (I) can be installed.

6. Install lower seal with lip toward bearing using a press, until seal is 7.8 mm (0.31 in.) below hub flange (J).

7. Install lower seal ring (K) inside seal lip with grease notch away from bearing.



M44948

8. Install spindle shaft (L).

IMPORTANT: Avoid damage! When installing spindle sheave nut, DO NOT hold hex end of spindle shaft in a vise. Hex end of the spindle shaft will be damaged, resulting in improper blade operation.

9. (Rear Discharge Deck) Install blade (M) and spacer.

10.(Mulching Deck) Install two blades.

11.Install washer (N), and cap screw (O) onto spindle shaft. Make sure that the concave side of washer faces the blade. Tighten cap screw to 67 N•m (50 lb-ft).

IMPORTANT: Avoid damage! Make sure the hex shaped hole in sheave is aligned with the hex end of the spindle shaft.

12.Hold the blade with a soft jaw vise or if spindle is in the mower deck, with a block of wood. Install spindle sheave (P), nut (Q), and lubrication fitting (R). Tighten nut to 127 N•m (94 lb-ft).

13.Remove cap screw, washer, blade and spacer or blades.

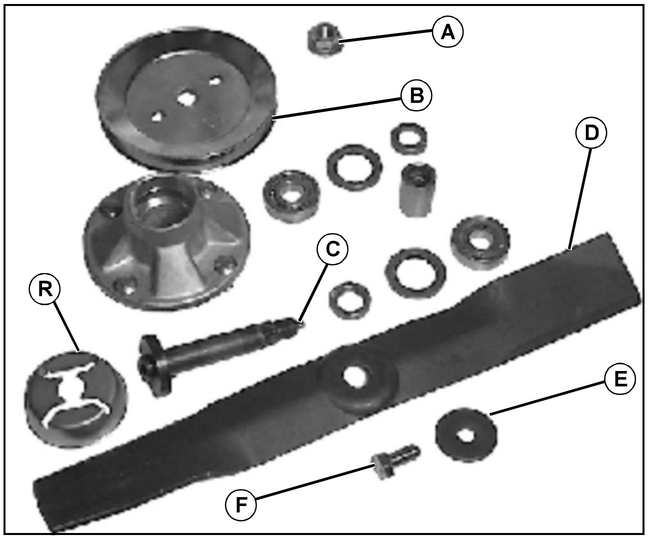
14.Lubricate spindle with multipurpose grease at lubrication fitting.

48-Inch Deck Spindles

CAUTION: Avoid injury! ROTATING BLADES/ MOVING PARTS. STOP engine. Remove ignition key. Wait for all moving parts to STOP.

1. Remove mower deck.

2. Remove mower drive belt.

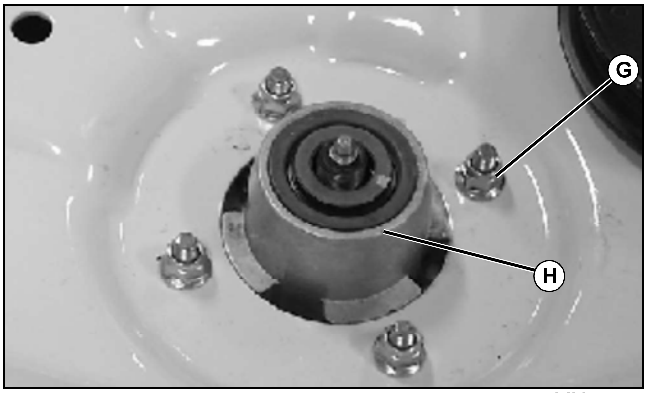


MX9610

3. Hold the blade (D) with a block of wood. Remove nut (A), spindle sheave (B), and lubrication fitting (C). If nut will not loosen, tighten blade cap screw to 156 N•m (115 lb-ft), remove nut and then blade cap screw.

CAUTION: Avoid injury! Wear gloves or wrap blade with a shop towel when removing/ installing blades to minimize the risk of personal injury. DO NOT hold blade with bare hands.

4. Remove cap screw (F), washer (E), blade (D), and deflector (R).



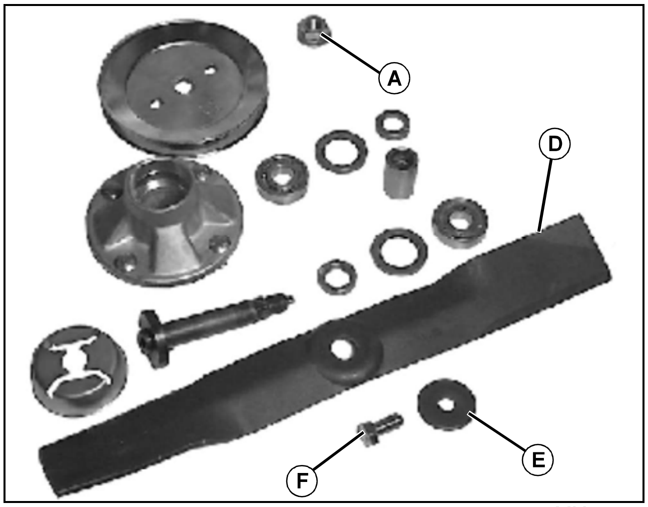
MX9609

5. Remove four nuts and washers (G) and spindle (H).

6. Make repairs as necessary. See “Disassembly and Inspection:” on page 574.

Installation:

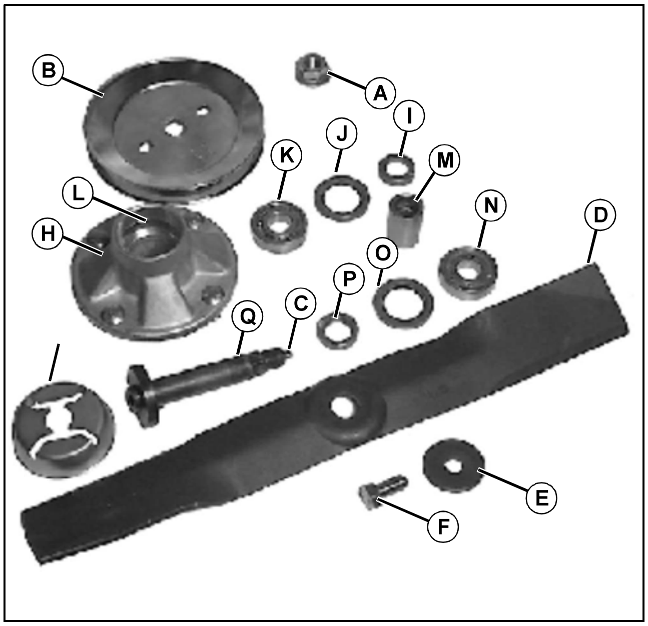
installation is done in the reverse order of removal.



MX9610

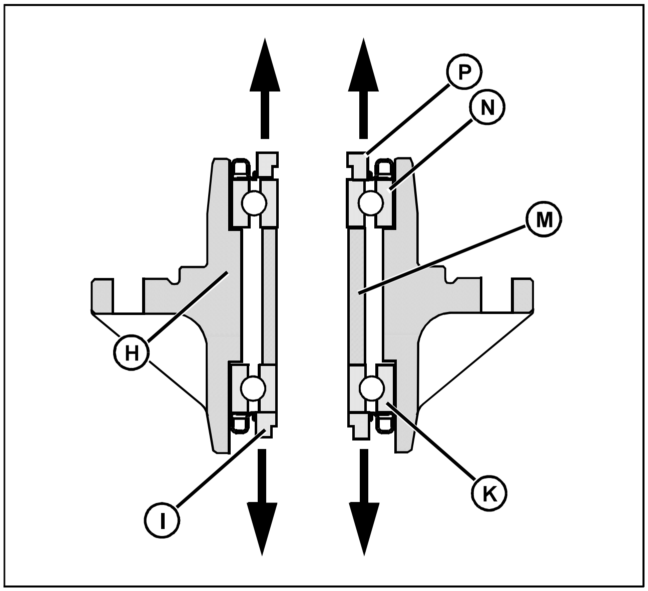
- Install blade (D) with blade wing toward top of mower deck.
- Install washer (E), and blade cap screw (F). Use a piece of wood to prevent the blade from turning, and tighten blade cap screw to 156 N•m (115 lb-ft).
- Tighten spindle sheave flange nut (A) to 163 N•m (120 lb-ft).
- Loosen blade cap screw and then tighten to 73 N•m (54 lb-ft).

Disassembly and Inspection:



MX9610

1. Pull spindle shaft (Q) and deflector (R) out of spindle hub (H).



MIF

2. Remove seal rings (I and P) noting location of notched sides (down).

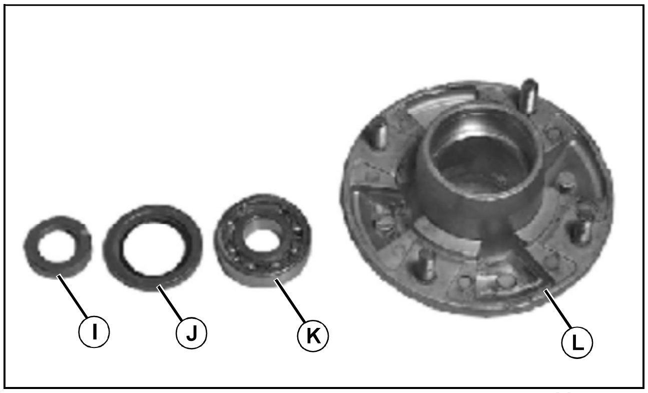
3. Push spacer (M) to one side and remove lower bearing (K) with a punch or a press.

4. Remove spacer (M).

5. Remove upper bearing (N) with a punch or press.

Assembly:

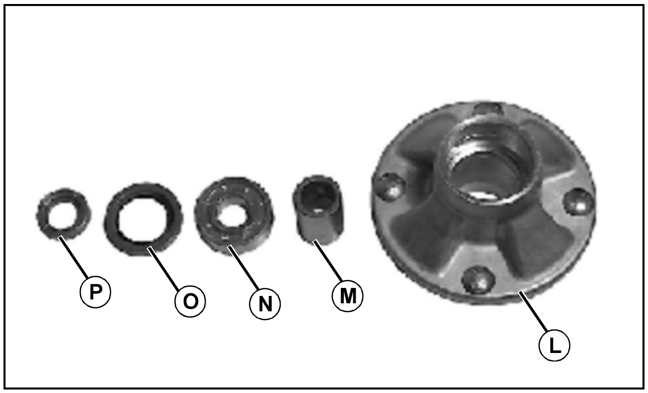
NOTE: Inspect all parts for wear or damage. Replace parts as necessary.



MX9611

1. Install upper bearing (K) tight against spindle hub shoulder (L) using a 1-13/16 disk and press.

IMPORTANT: Avoid damage! When using disk drivers, support both the inner and outer races of the upper and lower bearings when installing the lower bearing.

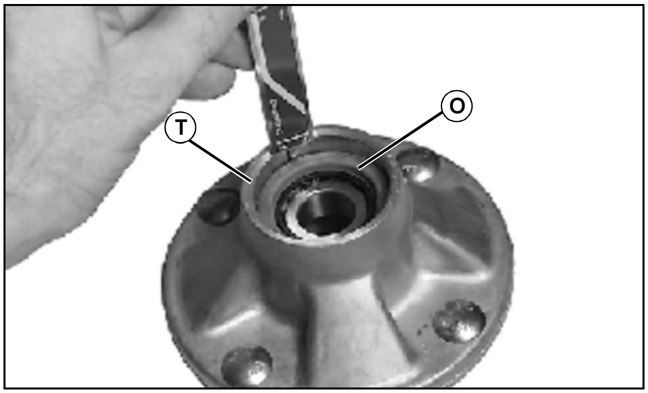


MX9612

2. Turn housing over. Support the assembly using a 1-13/16-in. disk against the upper bearing and a pipe approximately the same diameter against the disk. Pipe must extend beyond housing so the assembly is supported by the pipe NOT by spindle housing.

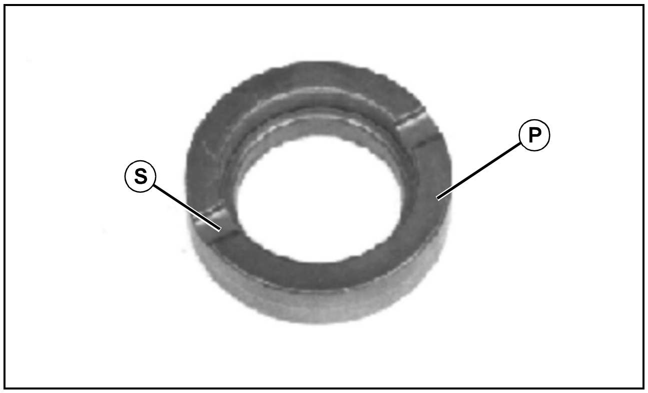
3. Place spacer (M) into housing. Center spacer on upper bearing.

4. Install lower bearing (N) in housing using a 1-13/16 in. disk and press. Press bearing until it is seated against spacer.



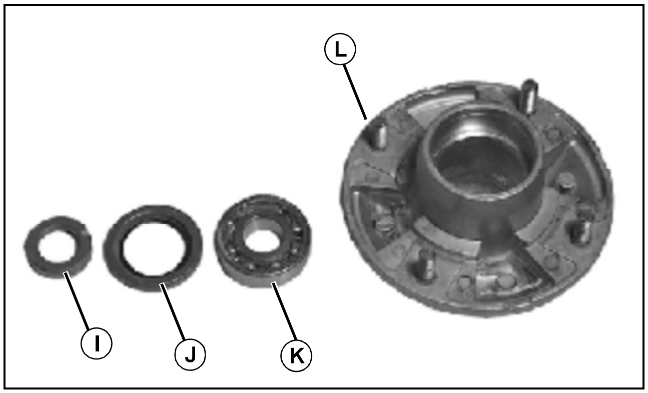
MX9613

5. Install lower seal (O) with lip toward bearing using a 1-13/16 in. disk and a press. Install to a depth of 7.3 mm (0.29 in.) below hub flange (T). Refer to cross section for correct seal installation.



M44950

6. Install lower seal ring (P), with grease notch (S) away from bearing, inside seal lip. Be careful not to turn lip of seal inside out when installing seal ring.



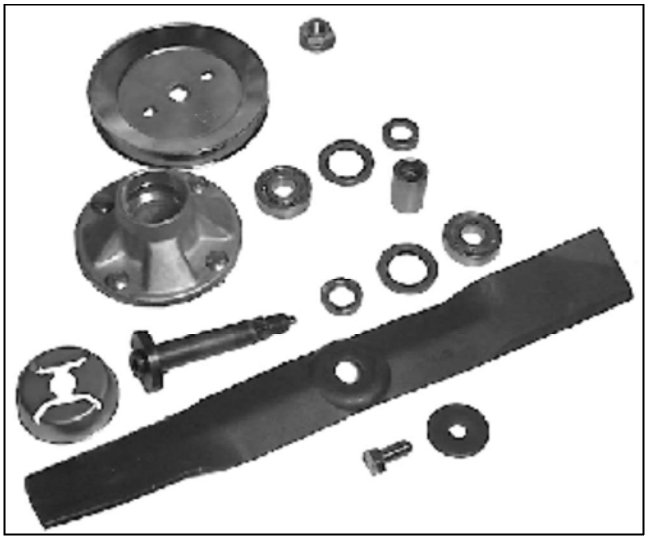
MX9611

7. Install upper seal (J) with lip toward bearing, tight against bearing using a 1-13/16 disk and press. Press until the seal is tight against the bearing.

8. Install upper seal ring (I), with grease notch toward bearing, inside seal lip. Be careful not to turn lip of seal inside out when installing seal ring.

IMPORTANT: Avoid damage! Do NOT install hexagon end of spindle shaft in a vice to install spindle sheave flange nut. Tighten nut after the spindle is installed in the mower deck. If this is not possible, place blade in a vice and attach spindle assembly. Tighten blade cap screw to 156 N•m (115 lb-ft) first, then tighten spindle sheave flange nut. Remove blade to install assembly in mower deck.

NOTE: The spindle housing must be attached to the deck shell BEFORE installing spindle sheave.



MX9810

9. Install spindle assembly in mower deck.

10.Install spindle shaft (Q) in housing (H).

11.Install sheave, flange nut, and lubrication fitting, being sure to index components to spindle shaft. Tighten flange nut securely, but do not torque at this time.

12.Install blade (D) with blade wing toward top of mower deck.

13.Install washer (E), and blade cap screw (F). Use a piece of wood to prevent the blade from turning, and tighten blade cap screw to 156 N•m (115 lb-ft).

14.Tighten spindle sheave flange nut to 163 N•m (120 lb-ft).

15.Loosen blade cap screw and then tighten to 73 N•m (54 lb-ft).

16.Lubricate spindle with multipurpose grease at lubrication fitting.

Specifications:

Spindle Retaining Nuts	**26 N•m (230 lb-in.)**
Blade Cap Screw	**73 N•m (54 lb-ft)**
Spindle Sheave Flange Nut	**156 N•m (115 lb-ft)**

54-Inch Deck Spindles

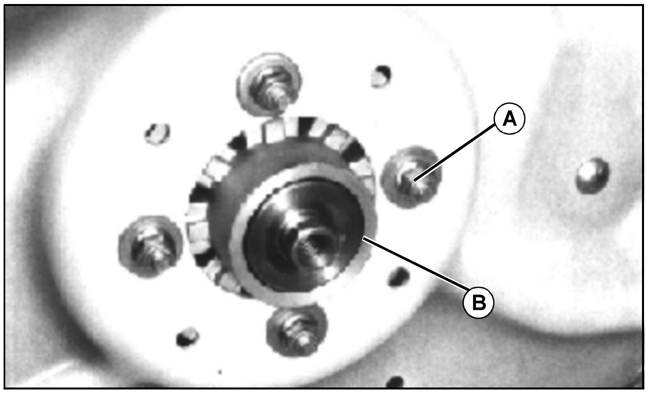
Removal and Installation:

CAUTION: Avoid injury! ROTATING BLADES/ MOVING PARTS. STOP engine. Remove ignition key. Wait for all moving parts to STOP.

1. Remove mower deck.
2. Remove mower drive belt.

CAUTION: Avoid injury! SHARP EDGES. Wear gloves or wrap blade with a shop towel when removing/installing blades to minimize the risk of personal injury. DO NOT hold blade with bare hands.

3. Remove mower blade(s).



M54685

4. Remove four nuts and washers (A), and spindle (B).

5. Check spindle for smooth bearing operation, wear, or damage. Repair or replace components as needed. See “Disassembly and Inspection:” on page 576

Installation is the reverse of removal.

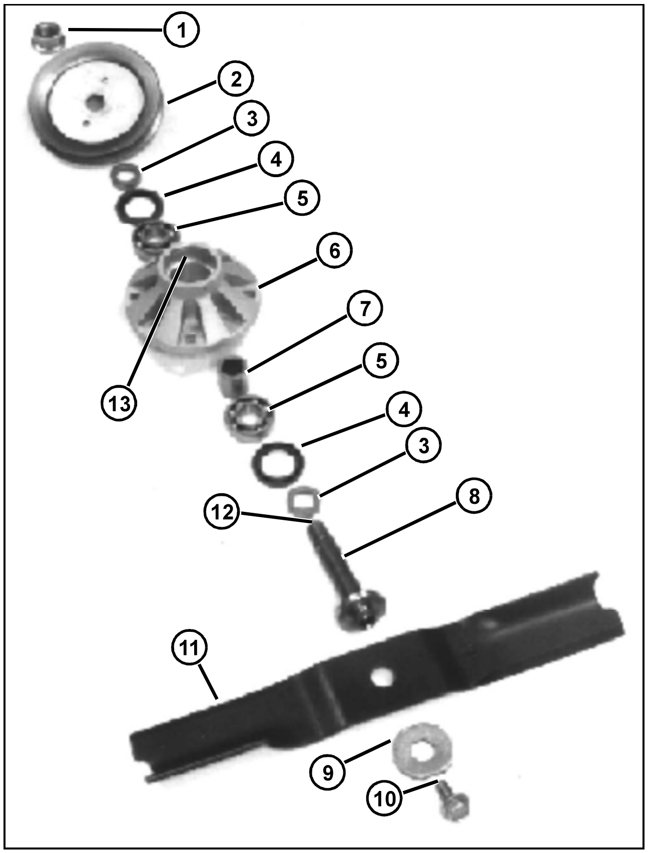
- Tighten spindle retaining nuts to 26 N•m (230 lb-in.).
- When installing blade, make sure concave side of blade washer faces blade.
- Tighten blade cap screw to 122 N•m (90 lb-ft).

Disassembly and Inspection:

CAUTION: Avoid injury! SHARP EDGES. Wear gloves or wrap blade with a shop towel when handling blades to minimize the risk of personal injury. DO NOT hold blade with bare hands.

IMPORTANT: Avoid damage! When removing spindle sheave nut, DO NOT hold hex end of spindle shaft in a vise. Hex end of the spindle shaft will be damaged, resulting in improper blade operation.

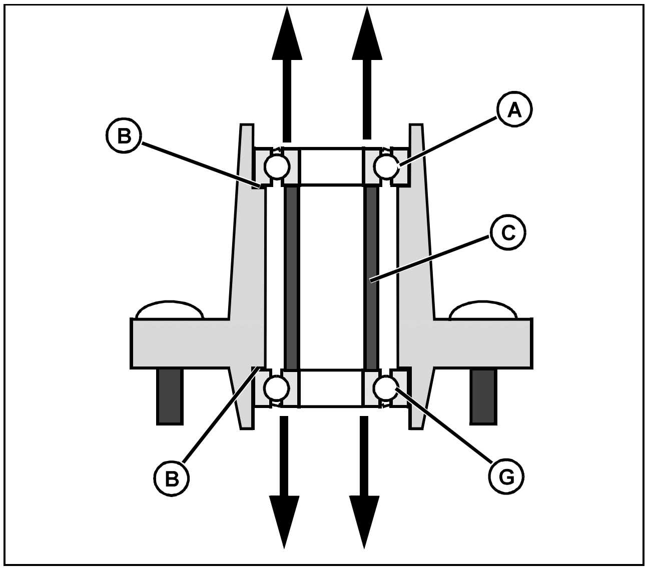
NOTE: If only the nut or spindle sheave need to be replaced and the spindle is still in the deck, use a block of wood to prevent the blade from turning. Remove nut and sheave, and replace parts as needed.



M44948

1. Remove spindle from deck. See “Removal and Installation:” on page 576.
2. Install blade, washer, and cap screw onto spindle shaft.
3. Secure the blade in a soft-jaw vise.
4. Remove nut, spindle sheave, and lubrication fitting.
5. Remove cap screw, washer and blade.
6. Using a suitable puller or press, remove spindle shaft from bearings and housing.
7. Note location of notched side, and remove two seal rings.
8. Remove seals using a suitable seal puller, or screw-type puller.

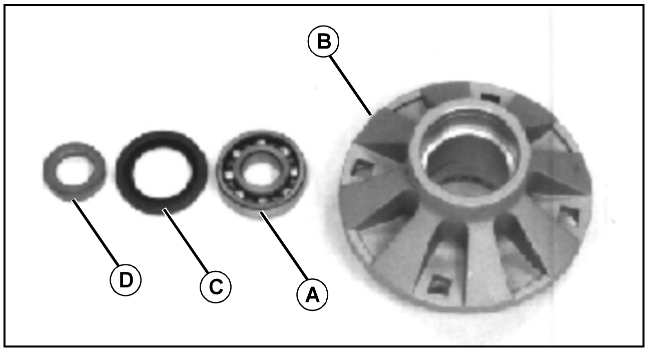
NOTE: Bearings (A and G) are seated against shoulder (B) in housing, and must be removed one at a time, from either side of the housing. Remove bearings only if replacement is necessary.



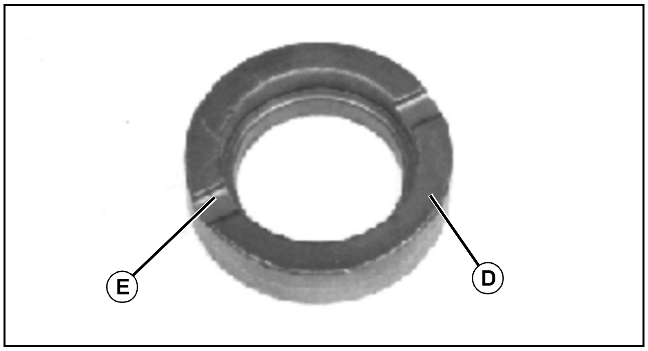
MIF

9. Remove one bearing using a suitable puller, or pin punch and hammer.
10. Remove spacer (C).
11. Remove second bearing using a press, or a suitable driver and a mallet.
12. Inspect all parts for wear or damage. Replace parts as needed.

Assembly:



M44949

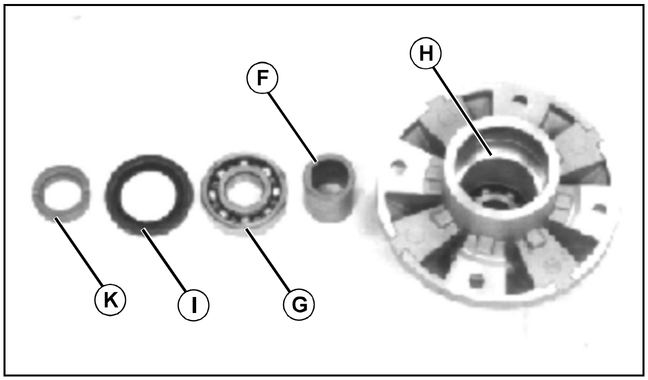


M44950

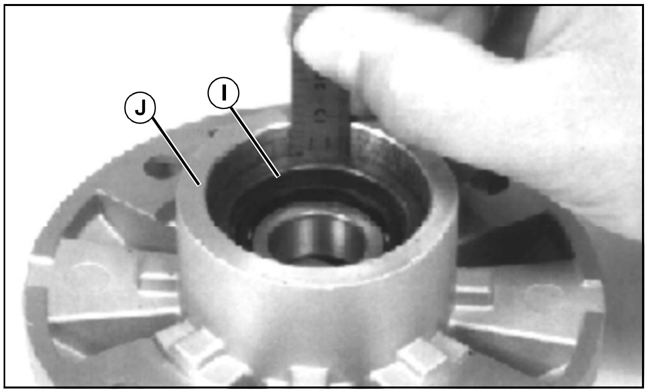
1. Using a press or a suitable seal driver and a soft-faced mallet, install upper bearing (A) tight against spindle hub shoulder (B).

NOTE: Install upper seal with lip toward bearing.

2. Using a press or a suitable seal driver and a soft-faced mallet, install upper seal (C) tight against bearing.
3. Install upper seal ring (D) inside seal lip with grease notch (E) toward bearing.



M44951

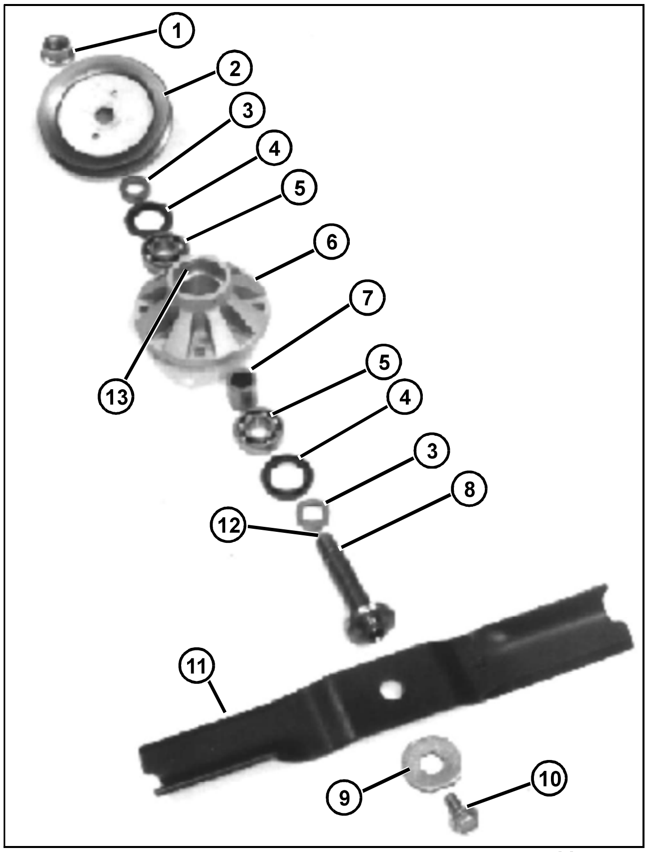


M44952

4. Install spacer (F).

IMPORTANT: Avoid damage! Do not press lower bearing (G) tight against hub shoulder (H). The bearing and seal must be installed to a specific dimension for proper sealing of spindle.

5. Install lower bearing (G) in hub using a press, just enough so the lower seal can be installed.
6. Install lower seal (I) with lip toward bearing using a press, until seal is 7.8 mm (0.31 in.) below hub flange (J).
7. Install lower seal ring (K) inside seal lip with grease notch away from bearing.



M44948

8. Install spindle shaft.

IMPORTANT: Avoid damage! When installing spindle sheave nut, DO NOT hold hex end of spindle shaft in a vise. Hex end of the spindle shaft will be damaged, resulting in improper blade operation.

9. Install blade, washer, and cap screw onto spindle shaft. Tighten cap screw to 122 N•m (90 lb-ft).

IMPORTANT: Avoid damage! Make sure the hex shaped hole in spindle sheave is aligned with the hex portion of the spindle shaft.

10. Hold the blade with a soft-jaw vise or if spindle is in the mower deck, with a block of wood. Install spindle sheave, nut, and lubrication fitting. Tighten nut to 163 N•m (120 lb-ft).
11. Remove cap screw, washer and blade.
12. Lubricate spindle with multipurpose grease at lubrication fitting.

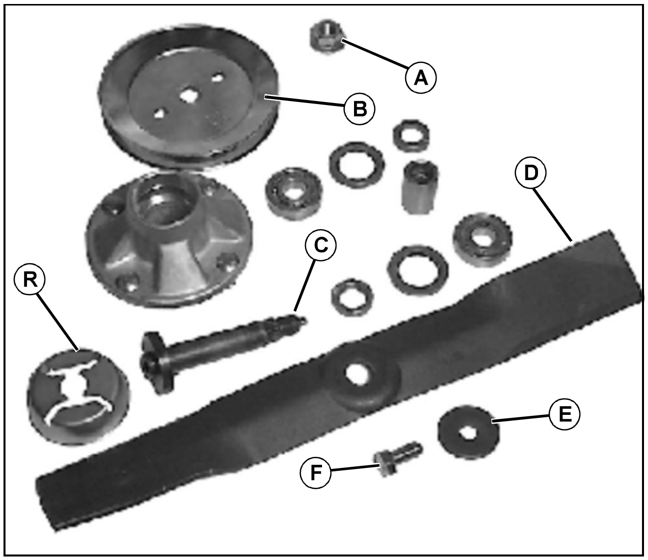
54-Inch Convertible Deck Spindles

Removal and Installation:

CAUTION: Avoid injury! ROTATING BLADES/ MOVING PARTS. STOP engine. Remove ignition key. Wait for all moving parts to STOP.

1. Remove mower deck.
2. Remove mower drive belt.

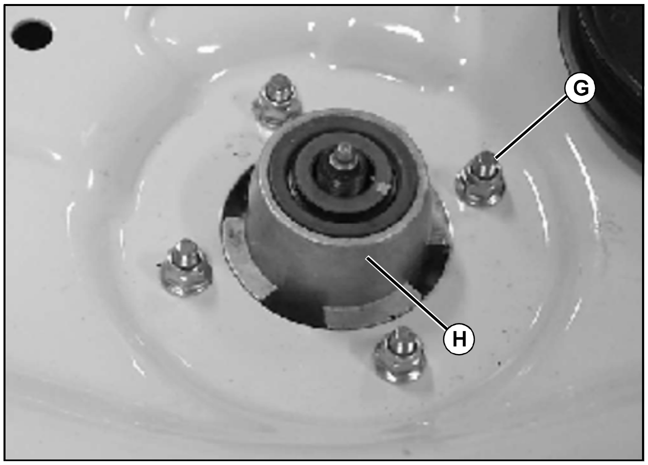
CAUTION: Avoid injury! Wear gloves or wrap blade with a shop towel when removing/ installing blades to minimize the risk of personal injury. DO NOT hold blade with bare hands.



MX9610

3. Hold the blade (D) with a block of wood. Remove nut (A), spindle sheave (B), and lubrication fitting (C). If nut will not loosen, tighten blade cap screw to 156 N•m (115 lb-ft), remove nut and then blade cap screw.

4. Remove cap screw (F), washer (E), blade (D), and deflector (R).



MX9609

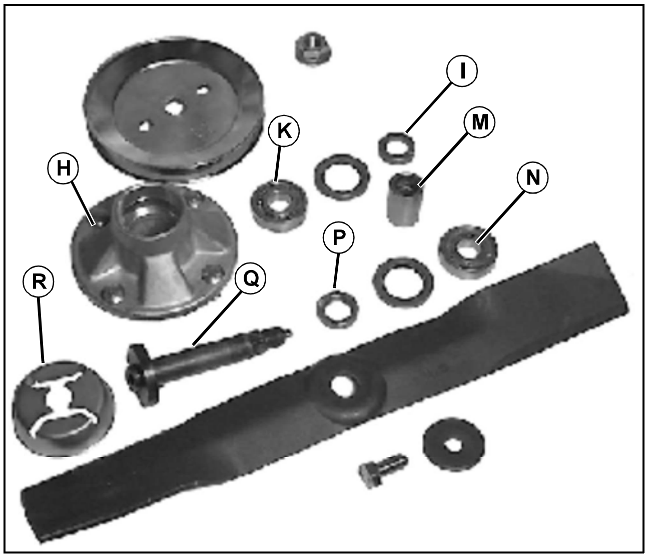
5. Remove four nuts and washers (G) and spindle (H).

6. Make repairs as necessary. See “Disassembly and Inspection:” on page 579.

Installation is done in the reverse order of removal.

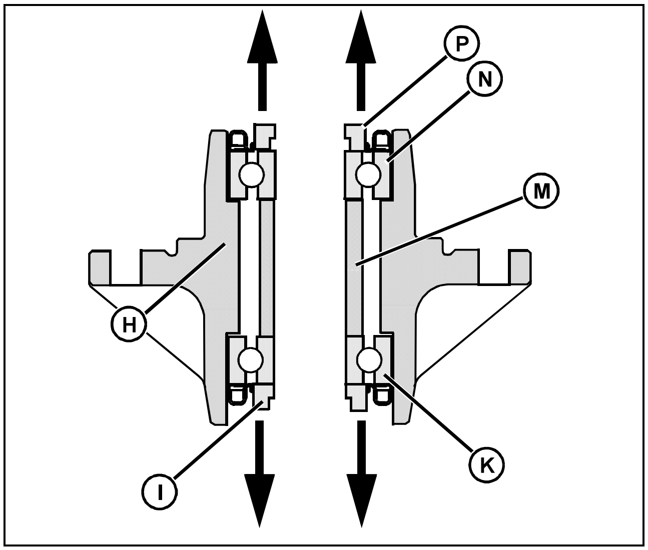
- Install blade (D) with blade wing toward top of mower deck.
- Install washer (E), and blade cap screw (F). Use a piece of wood to prevent the blade from turning, and tighten blade cap screw to 156 N•m (115 lb-ft).
- Tighten spindle sheave flange nut (A) to 163 N•m (120 lb-ft).
- Loosen blade cap screw and then tighten to 73 N•m (54 lb-ft).

Disassembly and Inspection:



MX9610

1. Pull spindle shaft (Q) and deflector (R) out of spindle hub (H).



MIF

2. Remove seal rings (I and P) noting location of notched sides (down).

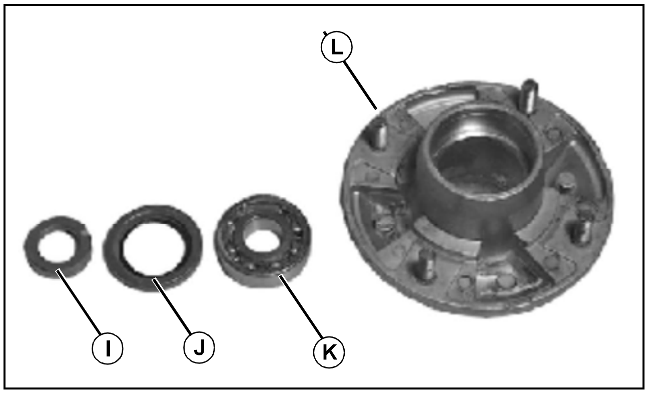
3. Push spacer (M) to one side and remove lower bearing (K) with a punch or a press.

4. Remove spacer (M).

5. Remove upper bearing (N) with a punch or press.

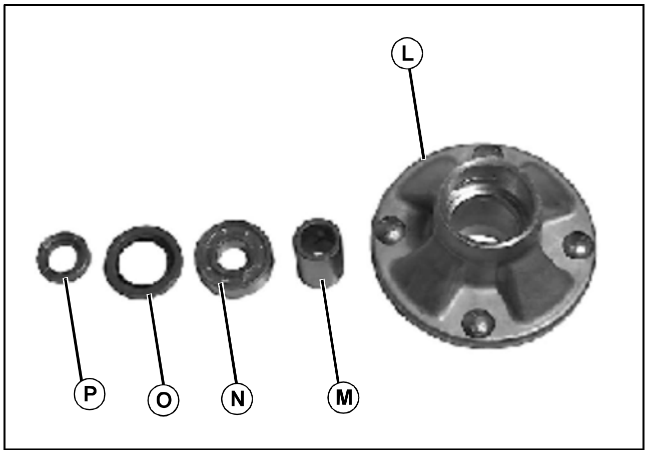
6. Inspect all parts for wear or damage. Replace parts as necessary.

Assembly:



M9611

1. Install upper bearing (K) tight against spindle hub shoulder (L) using a 1-13/16 disk and press.

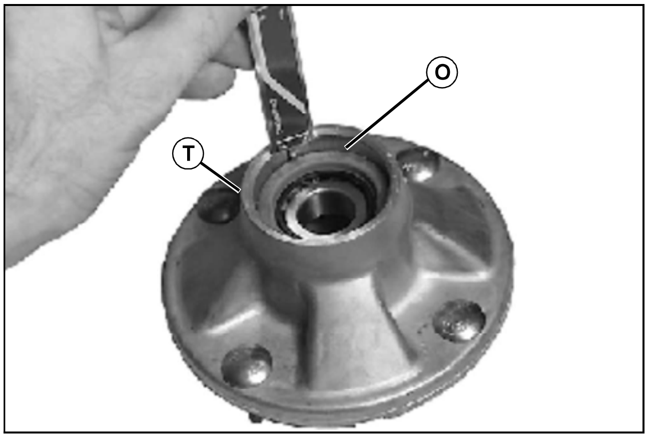


MX9612

2. Turn housing over. Support the assembly using a 1-13/16-in. disk against the upper bearing and a pipe approximately the same diameter against the disk. Pipe must extend beyond housing so the assembly is supported by the pipe NOT by spindle housing.

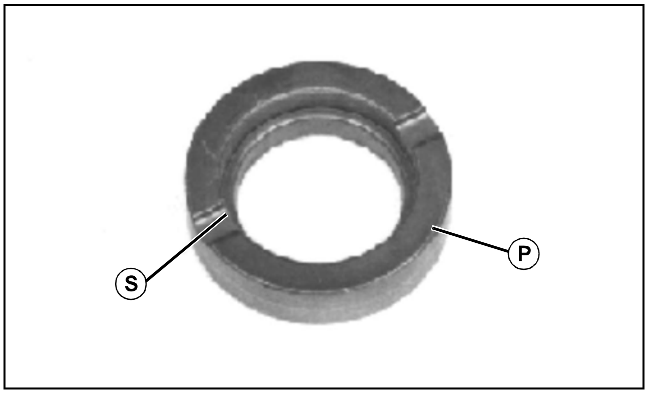
3. Place spacer (M) into housing. Center spacer on upper bearing.

4. Install lower bearing (N) in housing using a 1-13/16 in. disk and press. Press bearing until it is seated against spacer.



MX9613

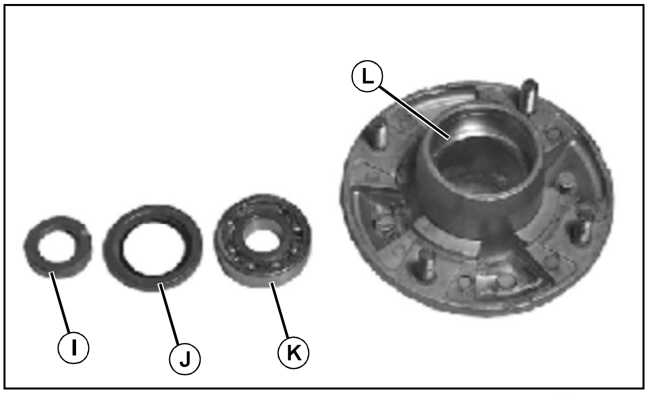
5. Install lower seal (O) with lip toward bearing using a 1-13/16 in. disk and a press. Install to a depth of 7.3 mm (0.29 in.) below hub flange (T). Refer to cross section for correct seal installation.



M44950

6. Install lower seal ring (P), with grease notch (S) away from bearing, inside seal lip. Be careful not to turn lip of seal inside out when installing seal ring.

7. Install upper seal (J) with lip toward bearing, tight against bearing using a 1-13/16 disk and press. Press until the seal is tight against the bearing.

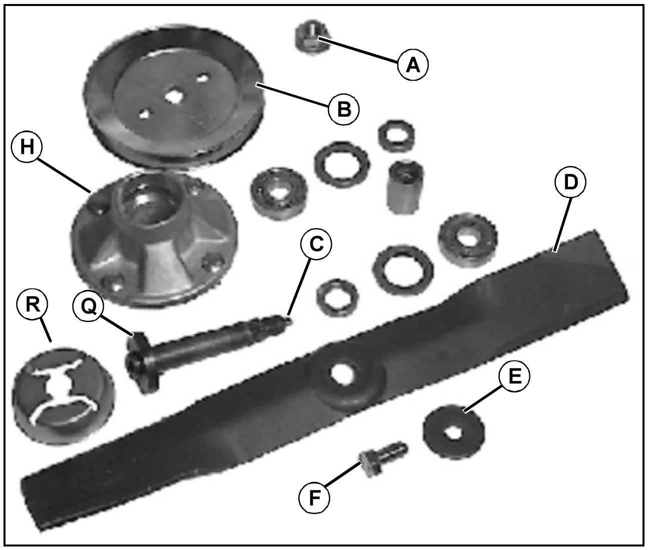


MX9611

8. Install upper seal ring (I), with grease notch toward bearing, inside seal lip. Be careful not to turn lip of seal inside out when installing seal ring.

IMPORTANT: Avoid damage! Do NOT install hexagon end of spindle shaft in a vice to install spindle sheave flange nut. Tighten nut after the spindle is installed in the mower deck. If this is not possible, place blade in a vice and attach spindle assembly. Tighten blade cap screw to 156 N•m (115 lb-ft) first, then tighten spindle sheave flange nut. Remove blade to install assembly in mower deck.

NOTE: The spindle housing must be attached to the deck shell BEFORE installing spindle sheave.



MX9610

9. Install spindle assembly in mower deck.

10.Install spindle shaft (Q) with deflector (R) in housing (H).

11.Install sheave, flange nut, and lubrication fitting, being sure to index components to spindle shaft. Tighten flange nut securely, but do not torque at this time.

12.Install blade (D) with blade wing toward top of mower deck.

13.Install washer (E), and blade cap screw (F). Use a piece of wood to prevent the blade from turning, and tighten blade cap screw to 156 N•m (115 lb-ft).

14.Tighten spindle sheave flange nut to 163 N•m (120 lb-ft).

15.Loosen blade cap screw and then tighten to 73 N•m (54 lb-ft).

16.Lubricate spindle with multipurpose grease at lubrication fitting.

Specifications:

Spindle Retaining Nuts . . . . 26 N•m (230 lb-in.)

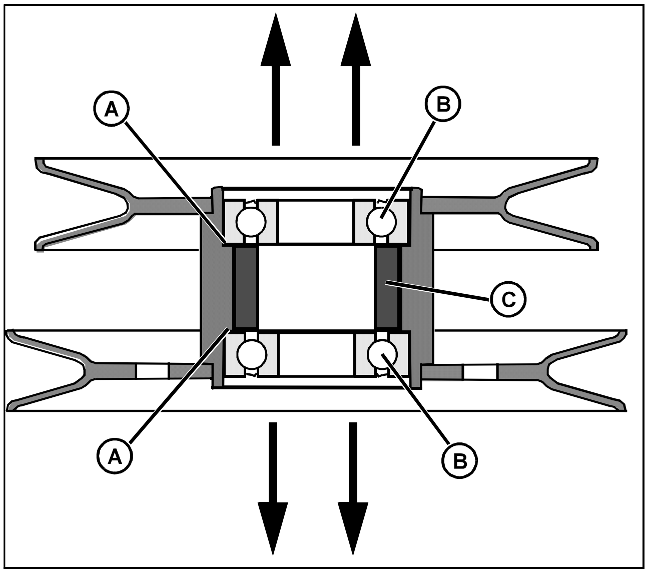
Blade Cap Screw . . . . 73 N•m (54 lb-ft)

Spindle Sheave
Flange Nut. . . . . 156 N•m (115 lb-ft)

Jack Sheave

Disassembly:

NOTE: Bearings are seated against shoulder (A) in jack sheave, and must be removed one at a time, from either side.
Remove bearings only if replacement is necessary.



MIF

1. Remove one bearing (B) using a suitable puller, or a pin punch and hammer.
2. Remove spacer (C).
3. Remove second bearing using a press, or suitable driver and mallet.
4. Inspect all parts for wear or damage. Replace as needed.

Assembly:

- Install bearings tight against shoulder (A) in jack sheave using a press, or suitable driver and mallet. Be sure to install spacer between bearings.

MISCELLANEOUS TABLE OF CONTENTS

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MISCELLANEOUS SPECIFICATIONS

Specifications

Torque Specifications

Front Axle Pivot Pin Cap Screws . . . . 42 - 87 N•m (30 - 64 lb-ft)

Drag Link Locknut . . . . 39 - 81 N•m (29 - 59 lb-ft)

Other Materials

Number	Name	Use
M79292	EP High Temperature Grease	Lubricate Spindles
T43512 / TY9473 / 242	Thread Lock and Sealer (Medium Strength)	Apply to threads of sheave set screws
TY6305	Clean and Cure Primer	Cleans parts and speeds cure of sealant

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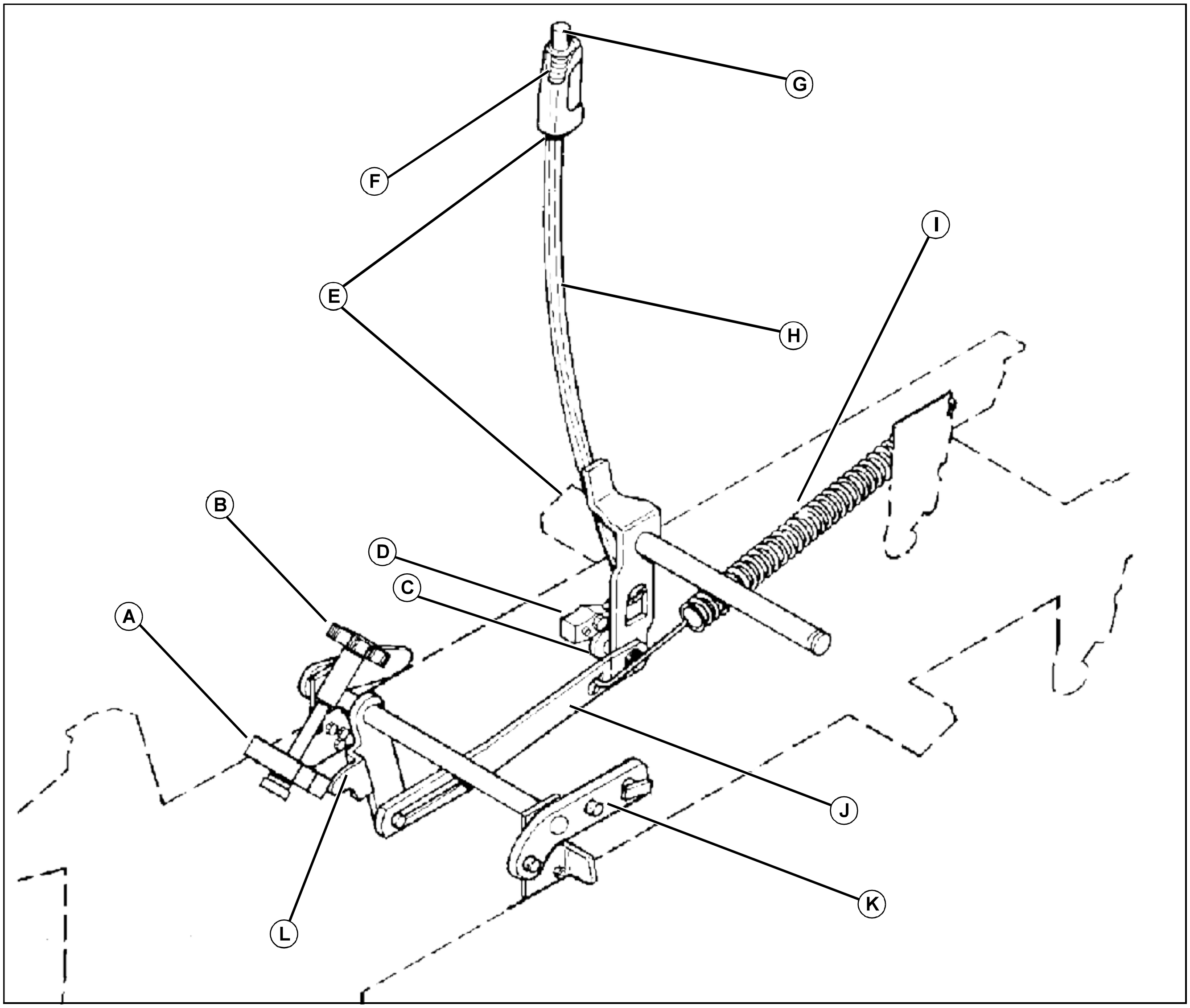
Component Location

Lift Assist and Depth Stop



M96621

A - **Mower Depth Stop Cam**
B - **Mower Deck Cutting Height Adjustment Knob**
C - **Latch**
D - **Latch Strike**
E - **Lift Handle Assembly**
F - **Return Button Spring and Cup**
G - **Lift Button**
H - **Latch Rod**
I - **Lift Assist Spring**
J - **Lift Link**
K - **Mower Deck Lift Arm**
L - **Depth Stop Arm**

Theory of Operation

Lift Assist and Depth Stop

Function:

To provide a means of controlling the cutting height of the deck and to allow the deck to be raised to a transport position.

Theory of Operation:

As the lift lever is pulled rearward (to raise attachment), it pulls the lift link forward. The lift link is attached to the lift shaft. The lift shaft rotates forward raising the lift arms and attachment. Also attached to the lift link is the lift assist spring. Spring tension helps pull the link forward, reducing the effort required to lift the attachment. The lift handle locks in the fully raised position with a latch and strike.

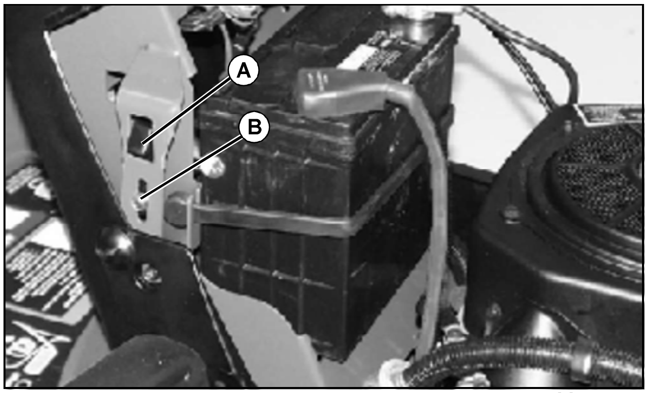
When the lift handle is lowered, the lift arms lower the attachment until the depth stop arm on the lift shaft contacts the depth stop cam. The depth stop cam has different cam heights which are selected by using the cutting height knob. This allows the attachment to return to a specific height each time the attachment is lowered.

The lift assist spring can be locked out by pushing the lift handle fully forward. A slot in the lift link allows the lift shaft and arms that hold the attachment to move without any effect from the lift assist spring. This results in full implement weight on the ground.

Tests and Adjustments

Hood Latch Adjustment

Hood should stay latched down when latches are properly adjusted.



M95619

1. Open hood and loosen cap screw (B) to adjust hood latch (A) on both sides of machine.
2. Move latch up or down and tighten cap screw for proper adjustment.

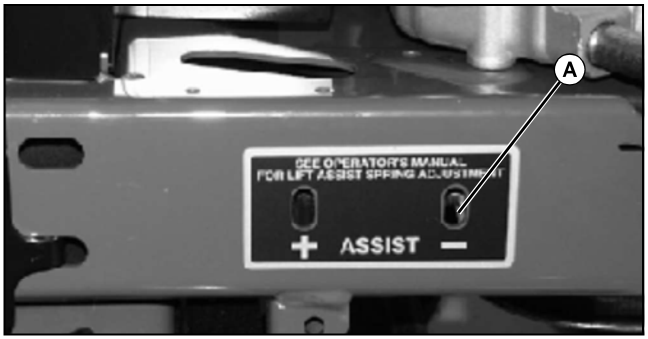
Lift Assist Spring Adjustment

Purpose:

The weight of the mower deck affects ease of lifting. Adjust lift assist spring tension when installing a different deck to machine.

Early Style:

Two Spindle Mower Deck:



M96440

The yellow spring plug should be visible in the (-) window (A).

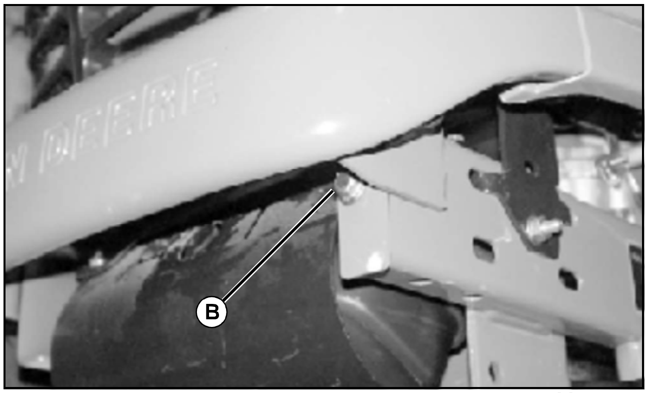
Three Spindle Mower Decks:

48C Mower: The yellow spring plug should be half way between the (+) and (-) windows

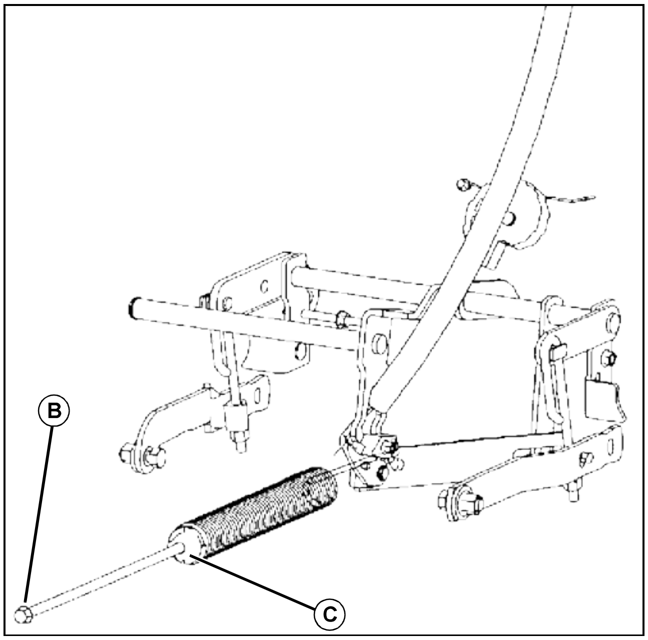
54-Inch Mower decks: The yellow spring plug should be visible in the (+) window.

To Adjust Spring Tension:

NOTE: The long adjusting bolt (B) is located behind front bumper under right side of frame.



M95562

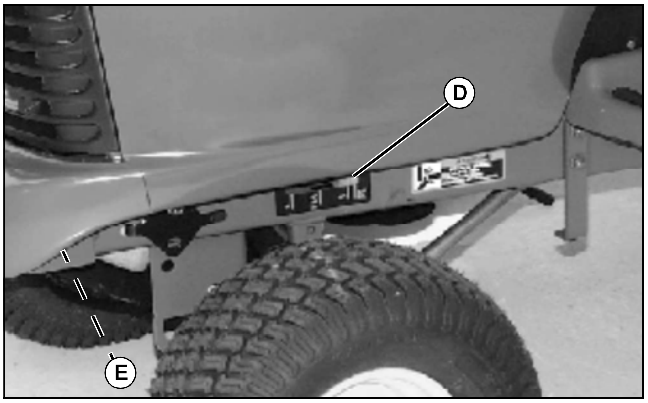


M96442A

- Turn long adjusting bolt (B) clockwise to increase spring tension and move yellow spring plug (C) toward the front of the machine or into the (+) window.
- Turn the long adjusting bolt counterclockwise to decrease spring tension and move yellow spring plug toward the rear of the machine or into the (-) window.

Late Style:

NOTE: The weight of the mower affects ease of lifting. Adjust the lift assist spring for your particular mower deck model. The slotted opening has indicator marks for different size decks.



MX8396

1. Make sure yellow indicator (D) is aligned with the proper mark for the mower deck installed. If not, adjust the lift assist spring so the indicator is aligned with the correct mower deck mark.
2. Turn adjusting bolt (E) at front of machine frame to adjust lift assist spring:

- Clockwise - Increases spring tension and moves indicator toward front of machine for heavier mowers.
- Counterclockwise - Decreases spring tension and moves indicator toward rear of machine for lighter mowers.

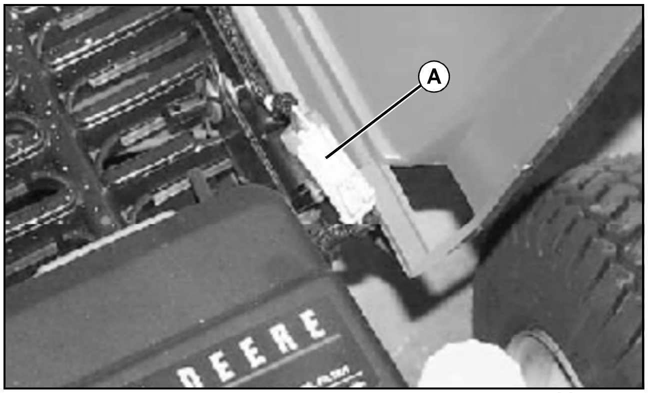
Repair

Hood Removal and Installation

Early Style

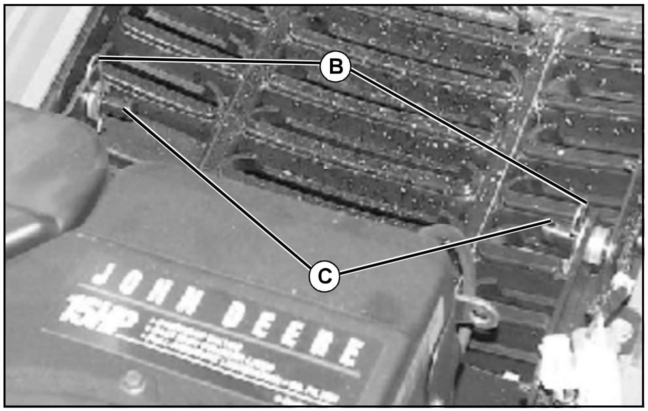
Removal:

1. Park machine safely, an d open hood.



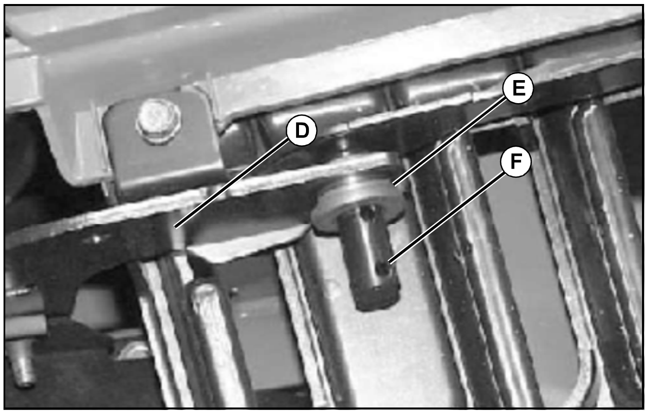
M95514

2. On right side of the machine frame, near the right front pivot, disconnect electrical connector (A) for headlights.



M95515

3. Remove two quick lock spring pins (B) from pivot pins (C).



M95516

4. Install quick lock spring pins to inner holes (F) on pivot pins to allow movement of the bushing (E) without complete removal.

NOTE: It may be necessary to lift up slightly on hood when sliding bushings.

5. Slide two bushings toward center of machine and out of hinge brackets (D).

6. Lift hood slightly and move toward front of machine. Remove hood.

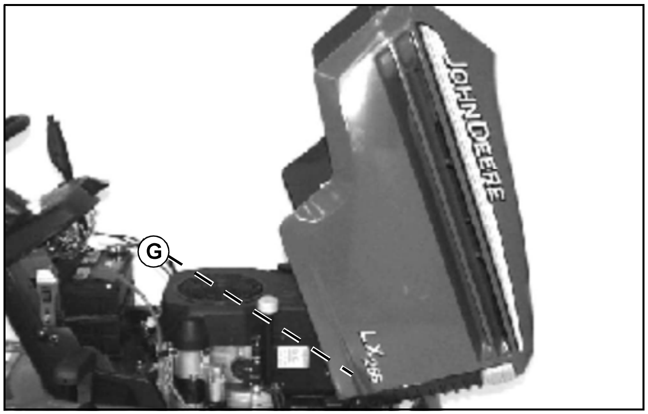
Installation:

Installation is the reverse of removal.

Late Style

Removal:

1. Park machine safely, an d open hood.



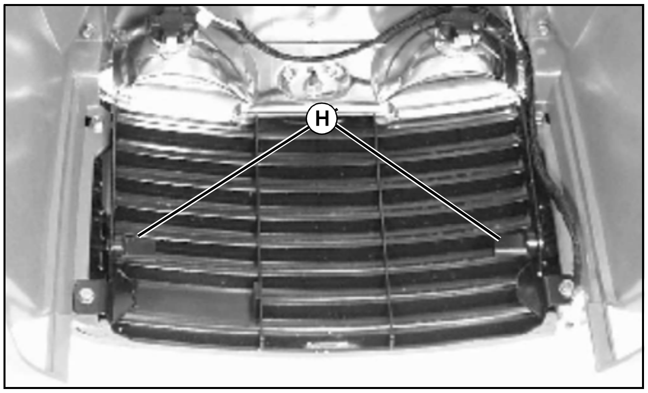
MX8401

2. Disconnect headlight wiring harness (G).

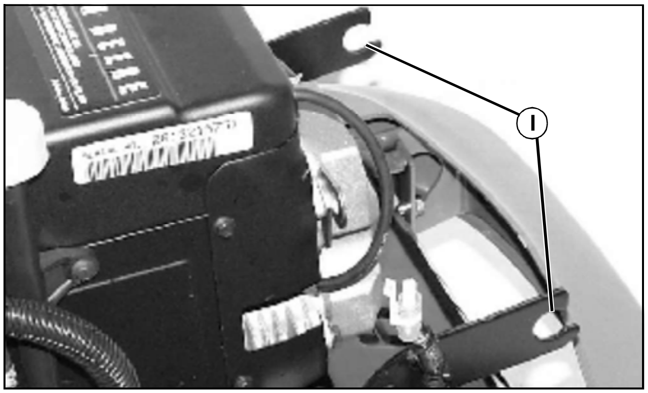
3. Lift and pull hood away from machine.

Installation:

IMPORTANT: Avoid damage! Avoid damage! Use care not to pinch or scrape headlight harness when installing hood.



M96024

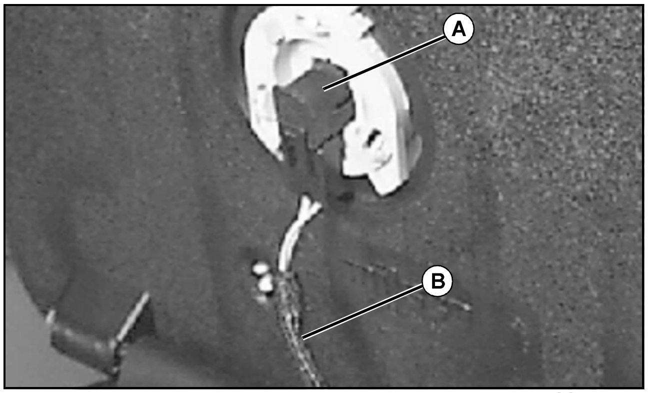


M96435

1. Align hood pivot studs (H) with pivot brackets (I) and install hood.
2. Connect wiring harness.
3. Close hood.

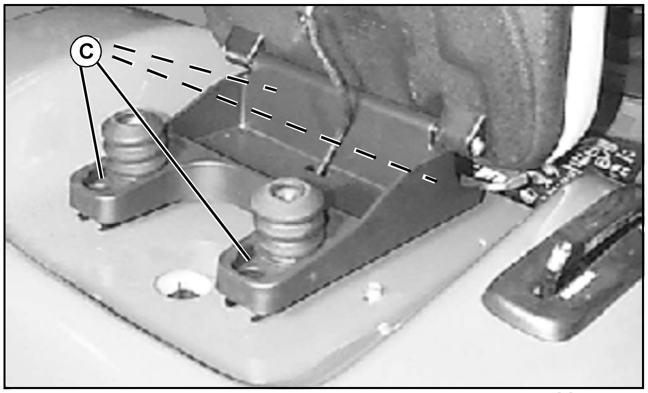
Seat and Support Removal and Installation

Removal:



M95319

1. Lift seat and disconnect wiring harness (B) from seat switch (A).



M95318

Picture Note: Right rear wheel removed for clarity.

2. Remove four nuts (C).
3. Remove seat and seat support.

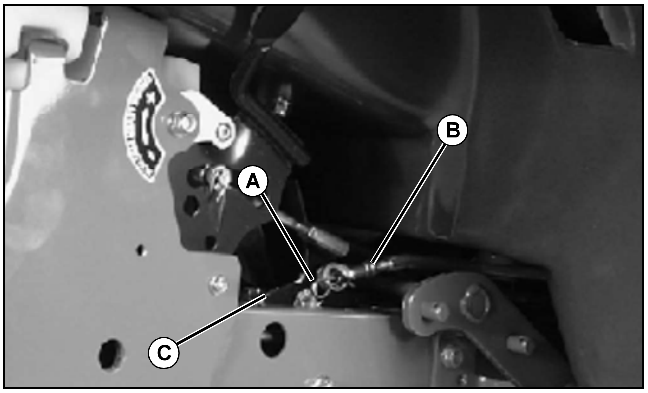
Installation:

Installation is the reverse of removal.

Fender Deck Removal and Installation

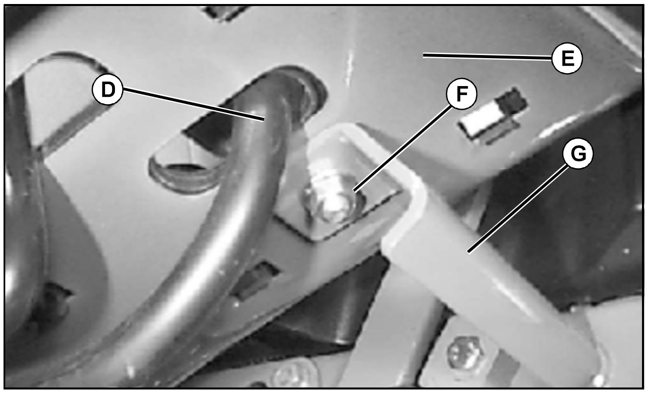
Removal:

1. Remove lift adjust stop knob.
2. Remove cruise control lever knob, lock washer, and nut.



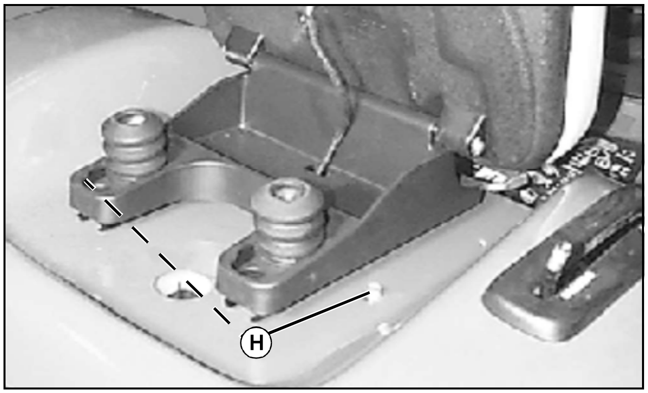
M95620

3. Remove spring clip pin (A) (located under seat and fender deck on right side of machine) and disconnect forward/reverse control rod (B) from control lever (C).



M95317

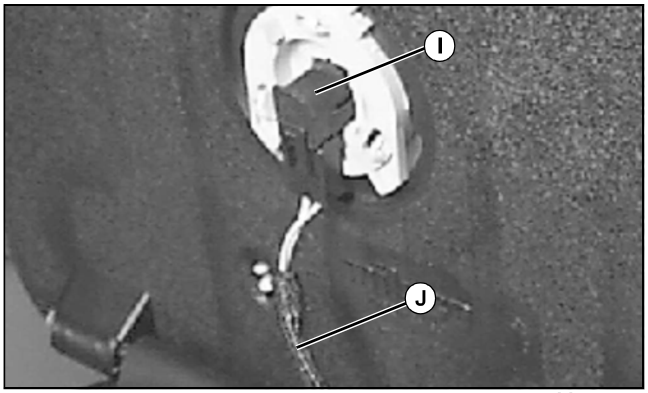
4. Under footrest area (right and left) (right side with forward pedal (D) shown), locate and remove two nuts (F) attaching front of fender deck (E) to machine frame (G).



M95318

5. Remove two cap screws (H) from rear of fender deck attaching fender deck to machine frame.

IMPORTANT: Avoid damage! Use caution when removing fender deck from machine to prevent damage to seat switch wiring harness



M95319

6. Disconnect wiring harness (J) from seat switch (I).

CAUTION: Avoid injury! Serious personal injury may result if gasoline vapor is ignited by a spark or open flame.

7. Remove fuel filler cap.

8. Obtain an assistant, and lift and remove fender deck from machine.

9. Replace fuel filler cap.

Installation:

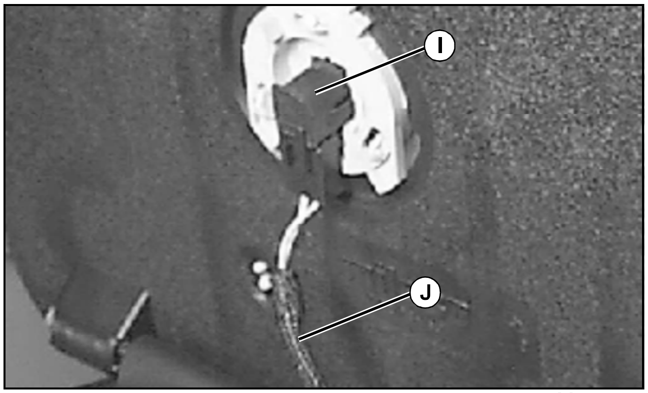
CAUTION: Avoid injury! Serious personal injury may result if gasoline vapor is ignited by a spark or open flame.

1. Remove fuel filler cap.

IMPORTANT: Avoid damage! When installing fender deck, route seat switch wiring harness through hole in fender deck and seat support. Position forward/ reverse control rod toward rear of machine to prevent interference when installing fender deck to frame.

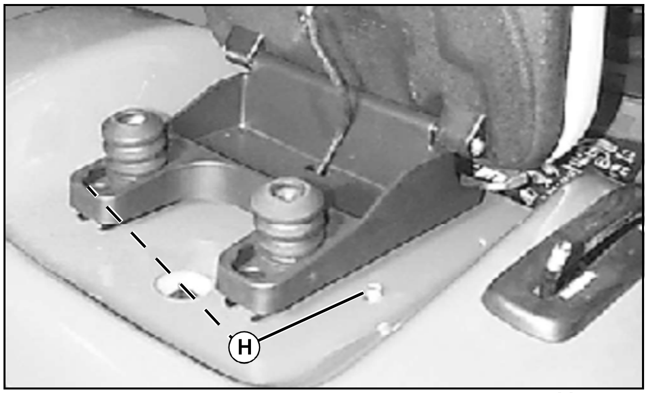
2. Obtain an assistant, and install fender deck to machine.

3. Replace fuel filler cap.



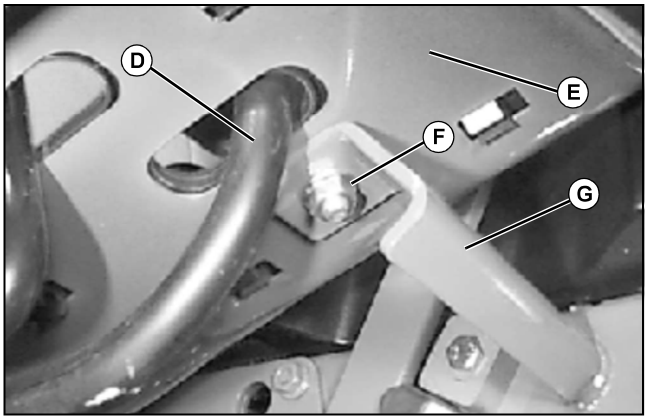
M95319

4. Connect seat switch (I) wiring harness (J).



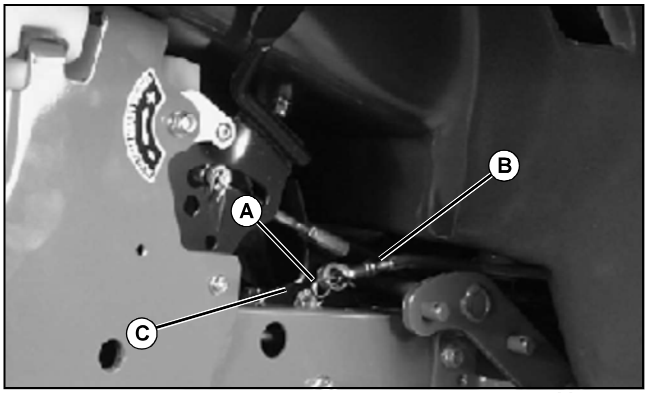
M95318

5. Install two cap screws (H) to rear of fender deck attaching fender deck to machine frame.



M95317

6. Under footrest area (forward pedal (D) on right side of machine shown), Install two nuts (F) to carriage bolts attaching front of fender deck (E) to machine frame (G).



M95620

7. Connect forward/reverse control rod (B) to transaxle control lever (C) and retain with spring clip pin (A).

8. Install lift adjust stop knob.

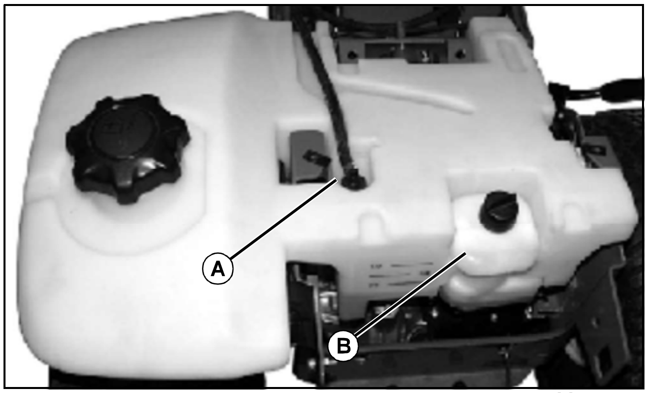
9. Install cruise control lever knob, lock washer, and nut.

Fuel Tank Removal and Installation

Procedure:

> **CAUTION: Avoid injury! Gasoline is explosive. DO NOT expose to flame or spark. Serious injury can result. Store in a properly marked, safe container. Wipe-up any spills IMMEDIATELY.**

1. Remove fender deck.



M99673

2. Disconnect and plug fuel line (A). Wipe up any spilled fuel.

3. Pull transaxle reservoir (B) from back of fuel tank and lift fuel tank off of machine.

Installation:

Installation is the reverse of removal.

Mower Deck Lift Removal and Installation

Removal:

1. Remove mower deck. See Mower Deck Removal and Installation for the appropriate deck in the Attachments section.

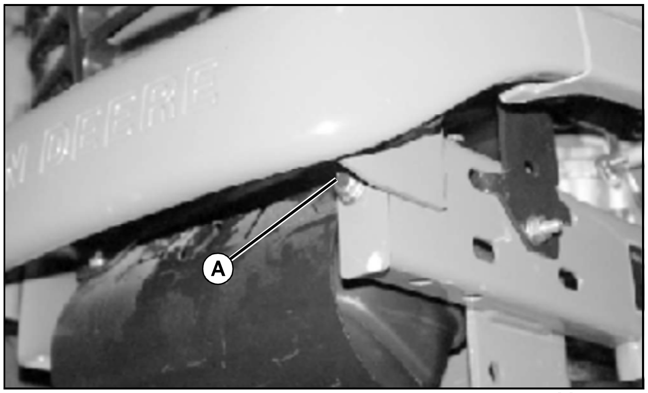
2. Disconnect negative (-) battery cable and then disconnect positive (+) battery cable. Remove battery.

3. Remove fender deck.

> **CAUTION: Avoid injury! SUDDEN LIFT LEVER MOVEMENT. With no weight on lift arms, spring will pull lift lever rearward when lock button is pressed. Use caution when releasing lift spring tension to minimize the risk of personal injury.**

4. If lift lever is not in rearward position, push lift lever forward against spring tension, and press in release button. Move lift lever rearward, and lock in the RAISE position.

5. Turn steering wheel to left until wheels stop.

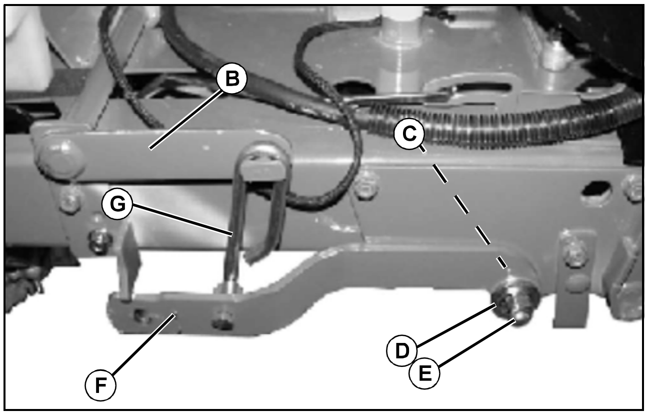


M95562

NOTE: For easier access to adjusting bolt (A), remove four screws and bumper cover.

6. Loosen lift spring adjusting bolt, located under left side of front fender, until all tension is removed from lift assist spring.

Lift Arms Removal and Installation:



M99674

1. Remove locknut (E), washer (D), spacer and cap screw (C). Remove lift arm (F).

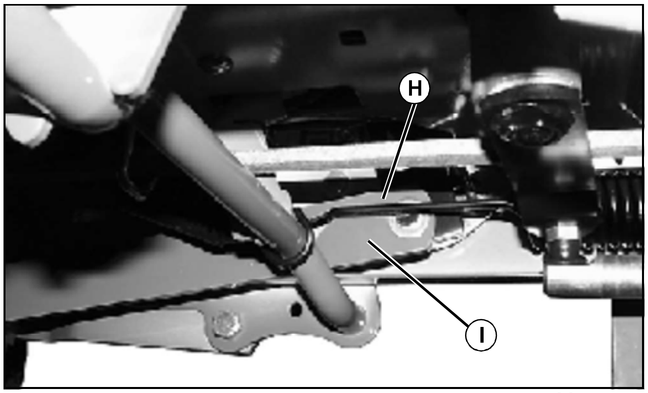
2. Remove lift rod (B) and lift link (G).

3. Repeat for other side.

Installation:

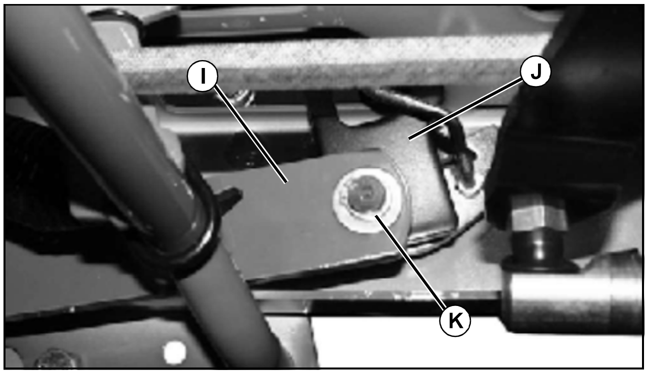
Installation of lift arms is the reverse of removal.

Lift Shaft Removal and Installation:



M99675

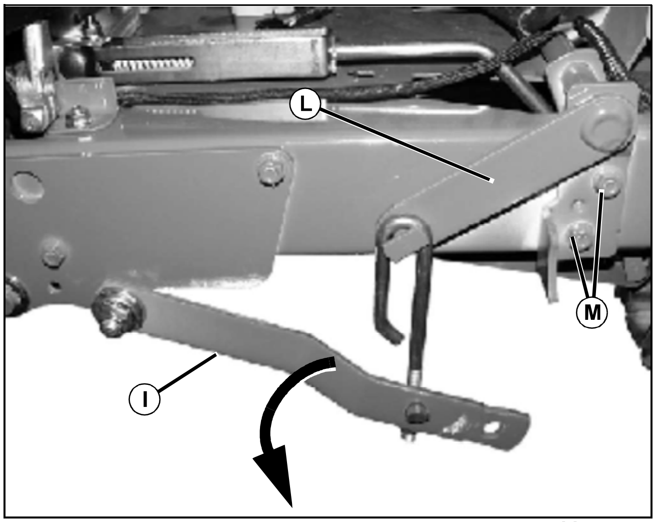
1. Disconnect rear of lift assist spring (H) from lift strap (I).



M99676

2. Remove snap ring and washer (K) attaching lift strap (I) to lift lever (J).

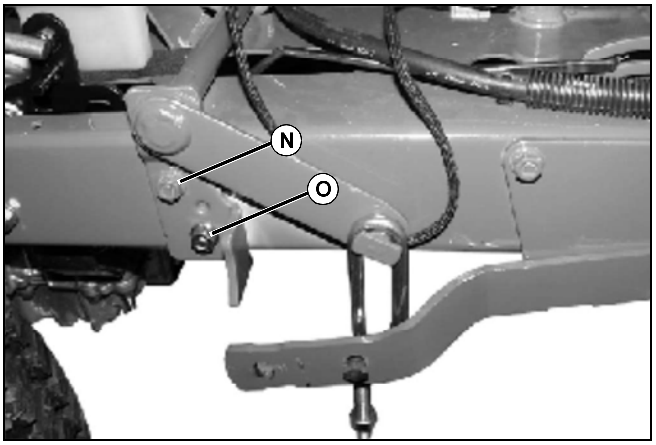
3. Move lift lever to forward (LOWER) position. Detach lift strap from pin on lift lever.



M99677

4. Rotate left lift strap (I) 90° and remove from lift shaft assembly (L).

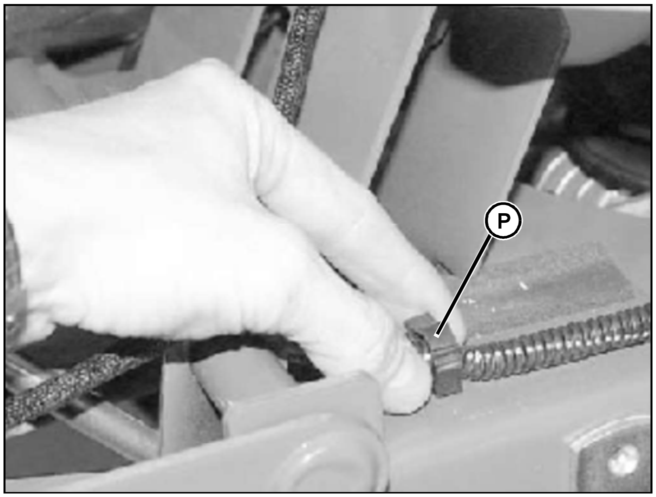
5. Remove two nuts and carriage bolts (M) attaching left side of lift shaft assembly to frame.



M99678

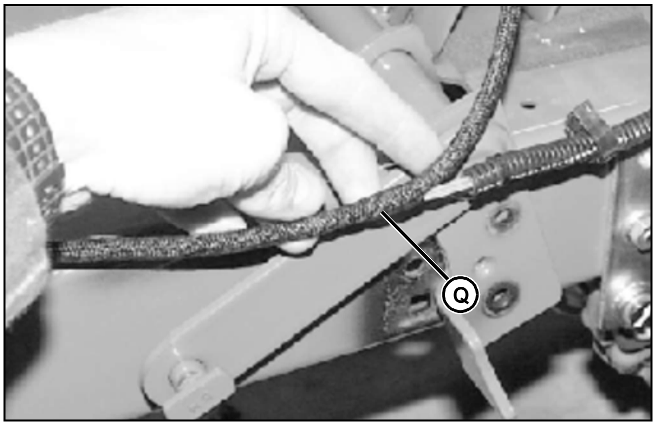
NOTE: Lower cap screw supports brake linkage. It is not necessary to remove the lower cap screw when removing the lift shaft assembly.

6. Remove upper nut and carriage bolt (N) attaching right side of lift shaft assembly to frame. Remove lower nut and push cap screw (O) toward center of machine until clear of lift shaft assembly.



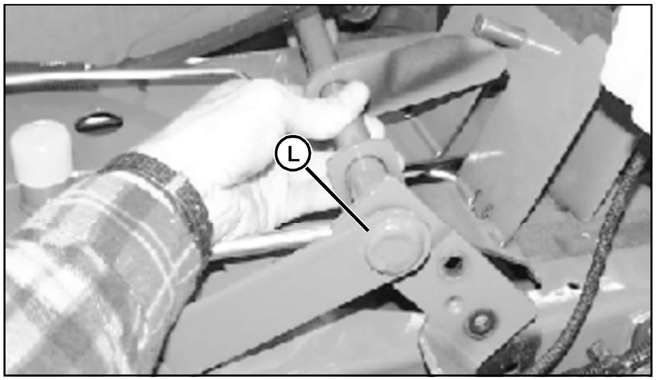
M99567

7. Lift and support the front of the fuel tank. Locate the wiring harness tie down clip (P) and disconnect it from the machine frame.



M95568

8. Slip the wiring harness (Q) over the left side of the lift shaft assembly.

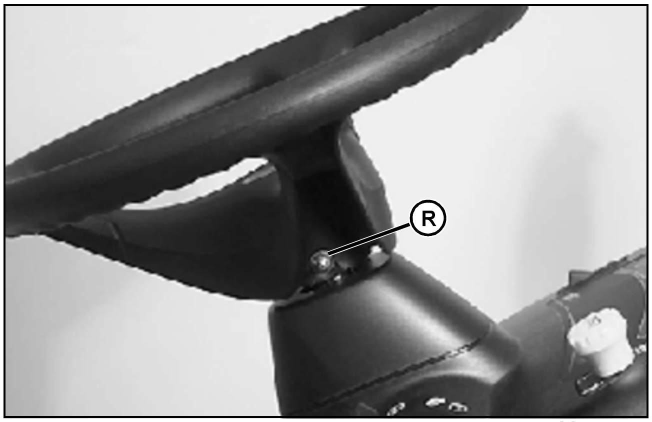


M95569

9. Remove lift shaft assembly (L).

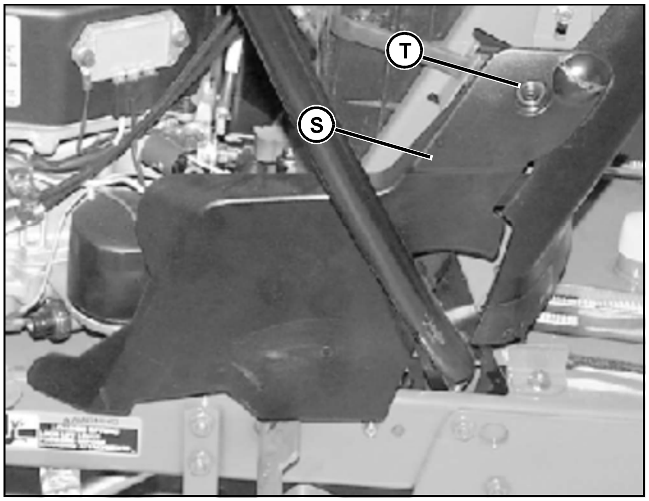
10. Installation of the lift shaft is the reverse of removal.

Lift Lever Removal and Installation:



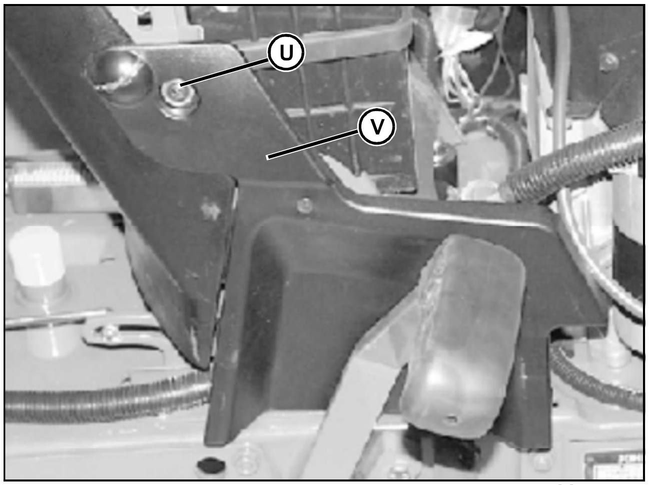
M96429

1. Remove locknut (R) and bolt securing steering wheel. Remove steering wheel.



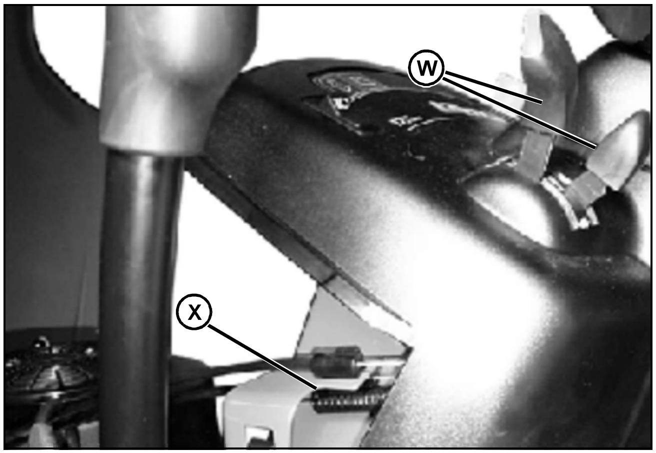
M95573

2. Remove screw (T) and left closeout panel (S).



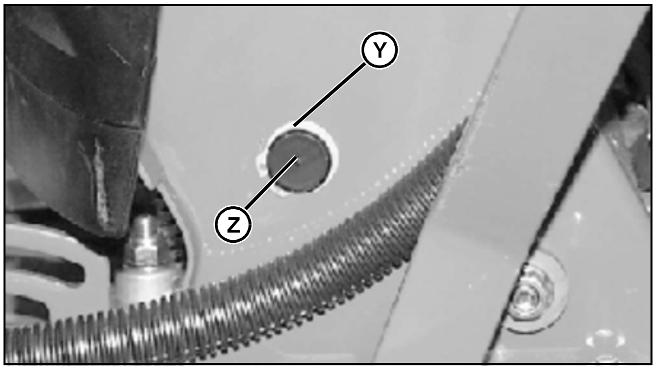
M95572

3. Remove screw (U) and right closeout panel (V).



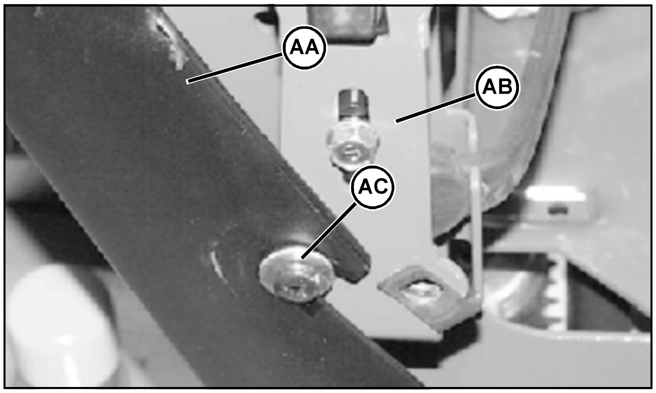
M95596

4. Remove choke cable return spring (X).
5. Remove choke and throttle control knobs (W).



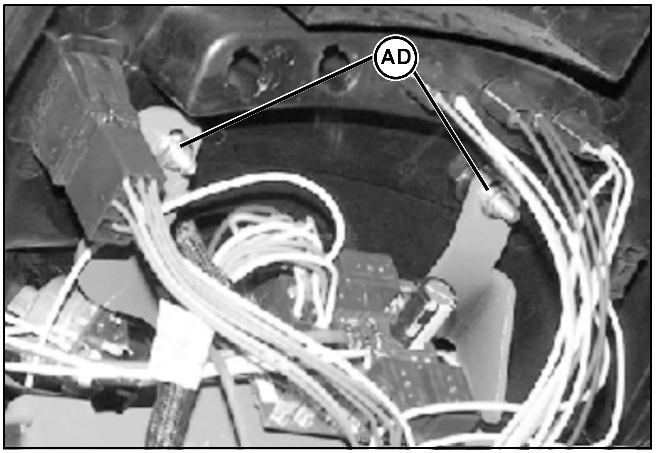
M95574

6. Remove snap ring (Y) from end of lift lever shaft (Z).



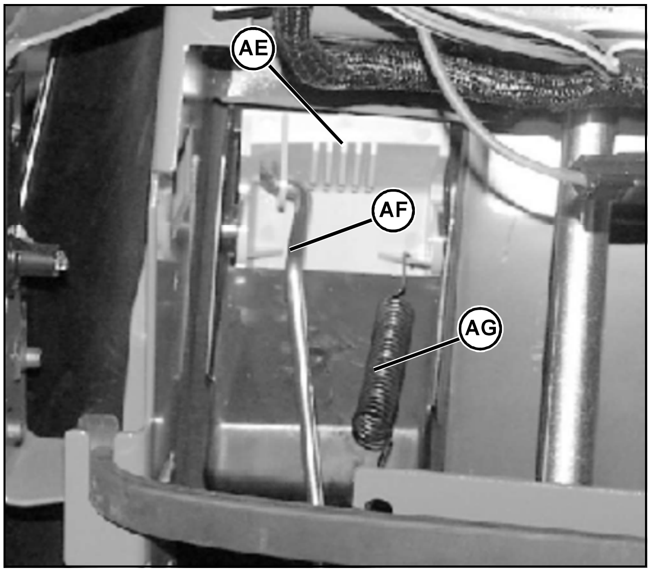
M95575

7. Loosen two screws (AC) attaching control panel (AA) to pedestal (AB).



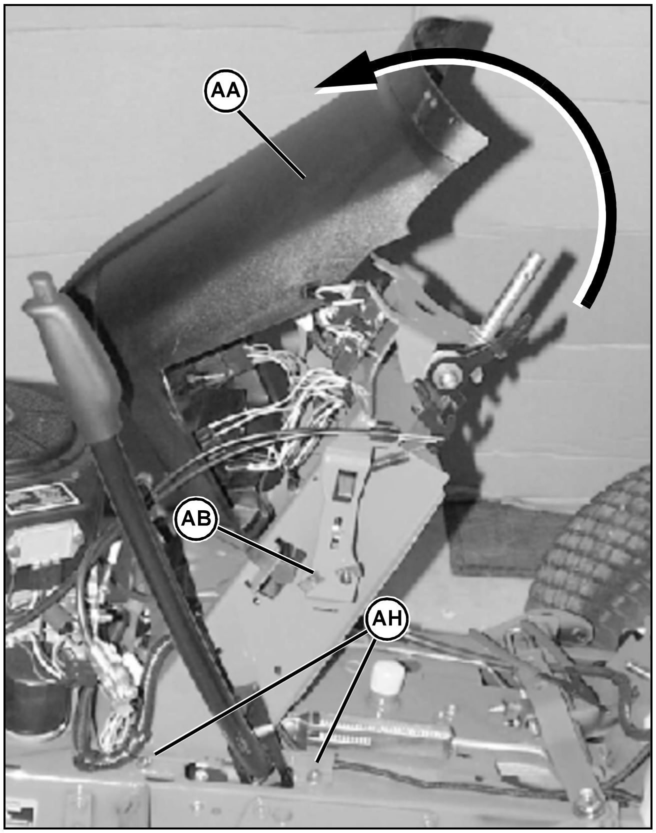
M95576

8. Remove two nuts (AD) attaching control panel to pedestal.



M95577

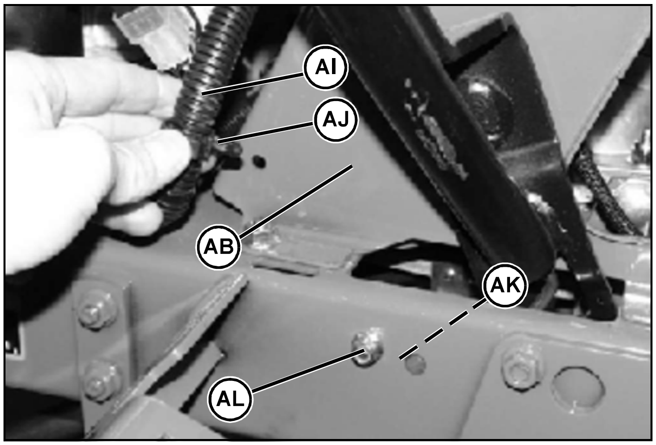
9. Remove spring (AG) from park brake handle (AE).
10. Disconnect sides of park brake handle from control panel and remove handle from park brake rod (AF).



M95578

11.Lift control panel (AA) off of pedestal (AB). Lift and rotate control panel and lay it on top of pedestal as shown.

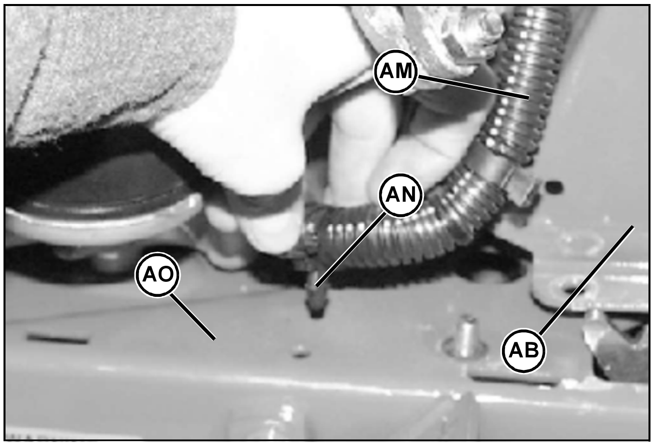
12.Remove two nuts (AH) attaching left side of pedestal to machine frame.



M95579

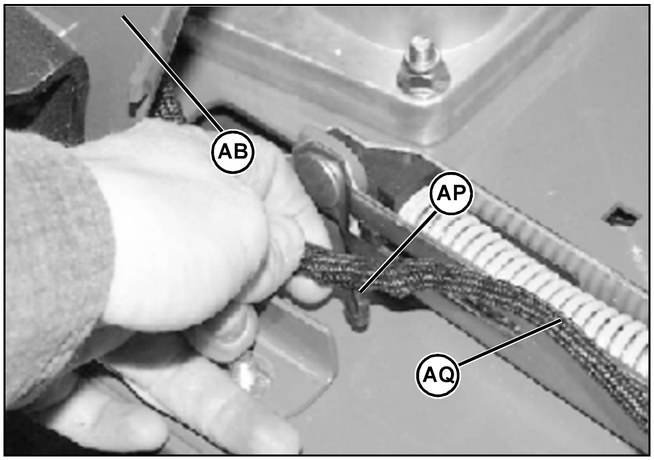
13.Disconnect wiring harness (AI) tie down clip (AJ) from pedestal (AB).

14.Remove locknut (AL) and latch strike (AK).



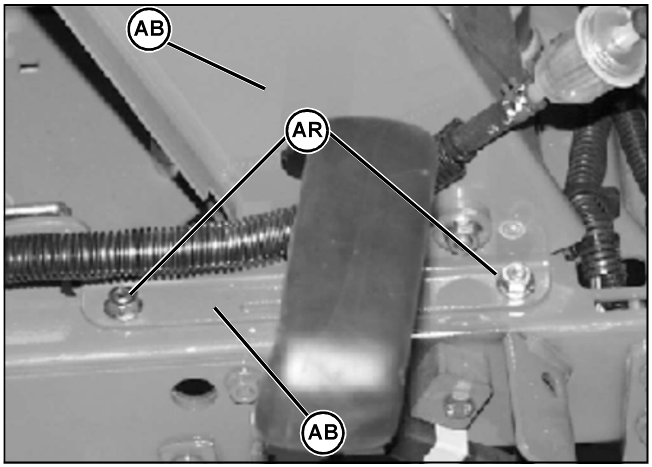
M95581

15.Disconnect wiring harness (AM) tie down clip (AN) from machine frame (AO) in front of pedestal (AB).



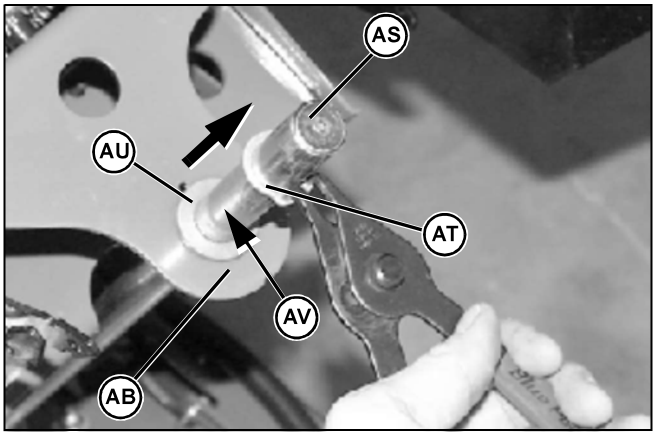
M95582

16.Disconnect wiring harness (AQ) tie down clip (AP) from machine frame behind pedestal (AB).



M95580

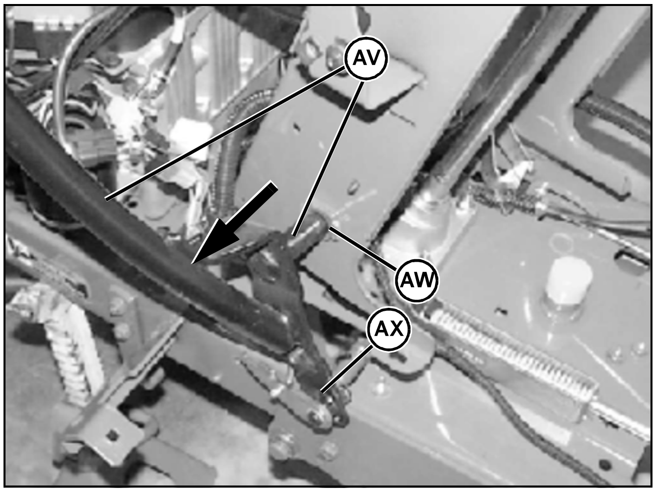
17.Remove two nuts (AR) attaching right side of pedestal (AB) to machine frame.



M95583

NOTE: Early style snap ring (AT) shown. Late style has cotter pin at location shown (AV).

18.Slide snap ring (AT) on steering shaft (AS) away from pedestal (AB) and steering bushing (AU).



M95584

19.Raise pedestal until lift lever and shaft (AV) can be removed from machine. Support pedestal and remove lift lever and shaft.

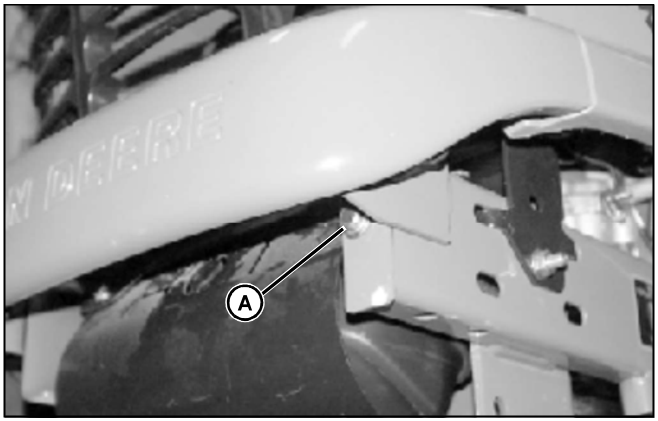
20.Inspect bushing (AW) and latch assembly (AX). Replace parts as needed.

21.Installation of the lift lever is the reverse of removal.

Lift Assist Spring and Tension Adjuster Removal and Installation

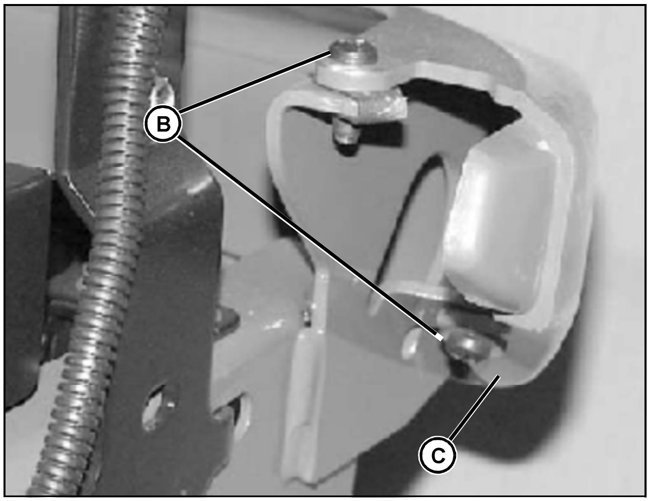
Removal:

NOTE: The following steps are for removal of the lift assist spring and tension adjuster bolt (A).



M95562

1. Remove hood.



M95518

2. Remove four screws (B) and bumper cover (C).
3. Hold spring and loosen tension adjuster until spring comes off.
4. Remove adjuster bolt (A) from front of machine.

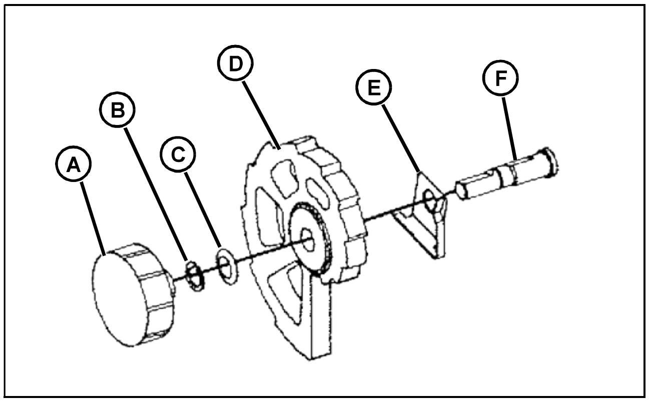
Installation is the reverse of removal.

- Adjust lift assist spring tension after assembly.

Height Adjuster Assembly Removal and Installation

Removal:

1. Remove fender deck.



MX11942

A - Knob, Depth Stop
B - Snap Ring
C - Washer
D - Adjuster
E - Spring, Detent
F - Shaft

2. Inspect all parts for wear or damage. Replace parts as necessary.

Installation:

Installation is the reverse of removal.

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